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THE TREATMENT OF COMPOUND INJURIES OF THE EXTREMITIES . . 321
John H. Garlock, M.D. . . . . New York, N. Y.
HEAD INJURIES IN CHILDREN 335
Penwick Beekman, M.D. . . . . New York, N. Y.
THE USE OF VISOR FLAPS FROM THE CHEST IN PLASTIC OPERATIONS UPON THE NECK, CHIN AND LIP 364
Leonard Freeman, M.D. . . . . Denver, Colo.
MALIGNANT DISEASE OF THE THYROID GLAND 369
John de J. Pemberton, M.D. . . . . Rochester, Minn.
TONSILLECTOMY WITH BLOODLESS TECHNIC 378
W. Wallace Walker, M.D. . . . . Baltimore, Md.
PRIMARY SARCOMA OF THE CLAVICLE 382
Lewis Barclay Bell, M.D. . . . . Chicago, Ill.
SOME UNDERLYING PRINCIPLES OF INTESTINAL SURGERY 387
J. Shelton Horsley, M.D. . . . . Richmond, Va.
PROPHYLACTIC GASTROSTOMY 395
Eric P. Quain, M.D. . . . . Bismarck, N. Dak.
OBSERVATIONS ON PEPTIC ULCER 401
Charles Bruce Morton, M.D. . . . . University, Va.
TREATMENT OF ACUTE CHOLECYSTITIS 423
Henry Otto Bruggeman, M.D. . . . . Fort Wayne, Ind.
POINTS IN TECHNIC OF OPERATIVE REMOVAL OF KIDNEY STONES . . 428
Edwin Beer, M.D. . . . . New York, N. Y.
CYSTOSCOPY REACTIONS 435
H. L. Weerbein, M.D. . . . . Brooklyn, N. Y.
THE ABDUCTION TREATMENT, A STANDARD PROCEDURE FOR ALL FORMS OF FRACTURE AT THE HIP-JOINT 442
Royal Whitman, M.D. . . . . New York, N. Y.
SUSPENSION OF THE FOOT IN TREATMENT OF POTT'S FRACTURE WITH PERSISTENT POSTERIOR DISLOCATION OF ASTRAGALUS . . . 450
John C. A. Gerster, M.D. . . . . New York, N. Y.
TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY 445
Stated Meeting Held November 23, 1927
BRIEF COMMUNICATIONS: *Brown and O'Keefe:* Sarcoma of the Ovary with Unusual Oral Metastases. *Rathbun:* Horseshoe Kidney. *Brauch:* Enterostomy in Typhoid Perforation 467
BOOK REVIEWS: *MacAusland:* Poliomyelitis, with Especial Reference to Treatment. *Chetwood:* Practice of Urology and Syphilology. *Rowlands and Turner:* The Operations of Surgery. *Clark, Norris* and *Giacchino Failla:* Radium in Gynecology 477

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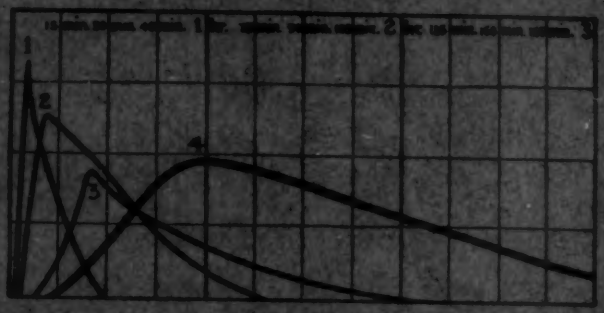

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ANNALS of SURGERY

VOL. LXXXVII MARCH, 1928 No. 3

THE TREATMENT OF COMPOUND INJURIES OF THE EXTREMITIES*

BY JOHN H. GARLOCK, M.D.

OF NEW YORK, N. Y.

FROM THE SECOND SURGICAL DIVISION OF THE NEW YORK HOSPITAL, SERVICE OF DR. EUGENE H. POOL

IN THIS age of mechanical industry and automobiles, hazards are great and accidents are many. Occupational injuries, it seems, are decreasing gradually, due, in great part, to the installation of safety devices, and also

FIG. 1.—Case No. I described in the text, showing the wounds three days after operation, and at the end of one year.

FIG. 2.—See figure 1.

to educational propaganda among the workmen by means of lectures, posters, etc. Injuries caused by motor vehicles are probably on the increase, as evi-

*Read before the Section of Surgery of the New York Academy of Medicine, November 4, 1927.

denced by recent statistics. The total number, augmented by accidental injuries received in other ways, is appalling when statistics covering large sections of the United States are analyzed. While, undoubtedly, the future will bring methods for decreasing the number of accidents, the situation at the present time must be met by the intelligent treatment of these injuries so that there will be a saving of life and limb with return of form and function as near to normal as possible.

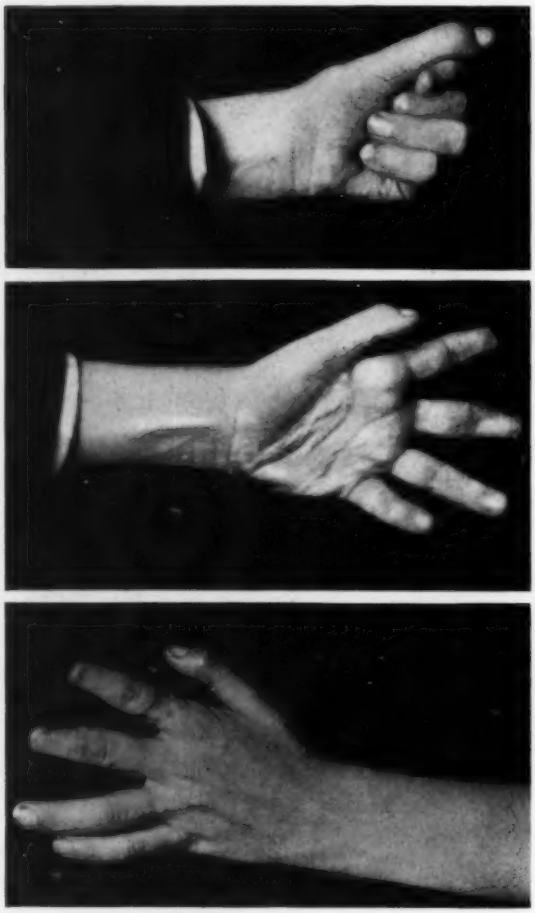


FIG. 3.—See figure 1.

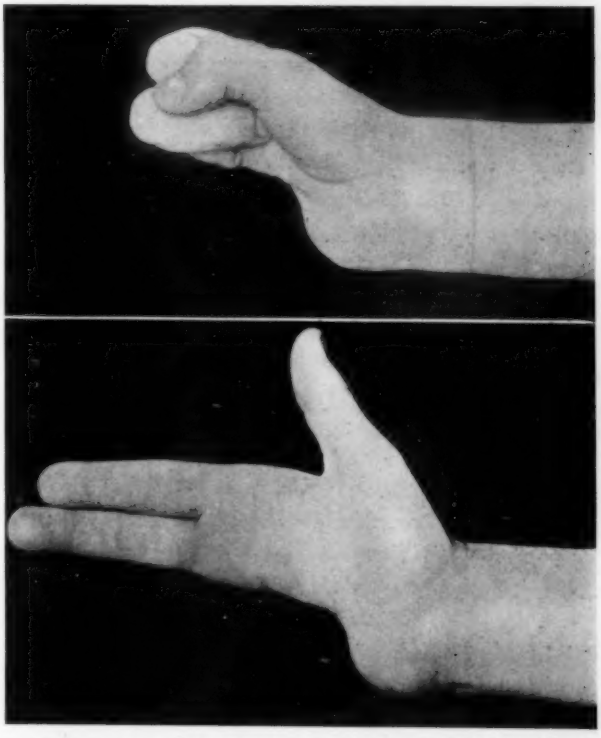
The writing of this paper was undertaken with the idea of presenting our experiences with the treatment of many varieties of injuries of the extremities, indicating the type of therapy that has given satisfactory results and citing cases illustrating points to be particularly emphasized. The cases forming the basis of this communication were patients on the second surgical division of the New York Hospital, which, by its geographical situation and by reason of its ambulance service, draws patients from factories, railroad yards, street accidents, etc.

The recent war taught a number of important lessons, and it is partly the purpose of this paper to emphasize again the practice and teaching of surgeons at its termination. While some of the principles had been advocated many years ago and were used sporadically, experiences during the war brought them forcibly to the attention of surgeons with a consequent more general adoption. Thus, Lucas-Championnierre, many years ago, championed the cause of early active motion in the treatment of fractures. Mechanical cleansing of wounds by irrigation is an old principle, as is also that of débridement.† While, during the war, these procedures received general adoption, there has since been some reluctance on the part of many surgeons to make use of these measures in civil surgery. The reason for this is not

† The word "débridement" is used in the sense of "wound excision".

clear. We, therefore, feel it sufficiently important to review the details and urge their adoption.

To attain the ideal above alluded to, the first step is the organization of a service in each hospital treating surgical patients, which will be under the direct supervision of one or more surgeons, especially interested in this type of work. This does not imply that these men need necessarily confine their work to this particular field, but it does predicate that their previous training has been sound and that their interest is keen. Secondly, the necessity of considering these patients as emergencies and treating them as such is apparent. The practice of postponing until the following day, the surgical treatment of a patient injured at night, is inexcusable and will soon demonstrate its inadvisability by the results obtained. Finally, when the principle of débridement, combined with that of irrigation of wounds becomes universally accepted as the basis of initial treatment of these cases, a marked improvement in results may be expected. Along with this, must be accepted the principle of early active motion, especially indicated in joint and tendon injuries and in a selected group of compound fractures.



FIGS. 4 and 5.—Case No. II reported in the text, shows the final result at the end of eighteen months. The patient has a very serviceable hand.

WOUNDS OF SOFT PARTS

In uncomplicated wounds of the soft parts, the ideal treatment consists in a thorough débridement, after the preliminary preparation to be outlined later, followed by primary suture without drainage. The results obtained have more than justified the additional expenditure of time and effort. The fine scar, the lack of deep scar tissue formation, the accurate approximation of anatomical structures and the rapid return of function are outstanding reasons for the recommended procedure. With smaller wounds, such treatment is not always feasible. Under these circumstances, a careful cleansing, proper iodinization, complete hæmostasis, and the insertion of a minimum

number of skin sutures will usually result in satisfactory healing. This brings up the question of lacerated wounds of the hand. Because of its manifold functions, its constant exposure and resultant multitudinous bacterial flora, the hand is peculiarly susceptible to infection. In addition, it must be remembered that because of its anatomical construction with the various bursæ, tendon sheaths, and closed spaces, the hand is particularly prone to infections resulting in serious disabilities. The writer is firmly convinced that, just as soon as the general practice of suturing lacerated wounds of the hand without drainage and without regard for the elementary principle of tension of tissues is stopped, the general incidence of hand infections will rapidly decline. The above statement applies solely to the practice of suturing without preliminary cleansing and débridement. In hand wounds of any magnitude, it is imperative that the patient be anæsthetized and a careful cleansing and débridement be done. Following such therapy, it is safe to suture the wounds loosely, avoiding undue tension and limiting the number of sutures to a minimum. When such a procedure cannot be carried out, cleansing, iodinization and the insertion of one or at the most, two, sutures, or the application of a few sterile narrow adhesive strips, should constitute the extent of treatment.

FIGS. 6 and 7.—This patient, age sixteen years, was operated upon July 26, 1927, eight hours after the receipt of an injury produced by the fender of an automobile. The structures found divided were: Flexor longus pollicis, flexor sublimus and profundus tendons of the index and middle fingers, and the median nerve. The tendons were repaired by the technic described in a previous communication (ANNALS OF SURGERY, January, 1927). The nerve was repaired by six perineural sutures of fine silk. Photographs indicate the result at the end of two months.

CASE I.—J. D., seven years of age. Admitted January 8, 1927, discharged January 18, 1927. Just before admission, this patient was playing with a toy gun. He placed a .45-calibre rifle cartridge in the gun, and tried to fire it. As the cartridge was too long to fit in the barrel of the gun, the patient held it in his left hand and pulled the trigger. The cartridge exploded into the palm of the left hand.

Examination showed that the thumb was almost completely avulsed at the carpo-

metacarpal joint. There was an irregularly shaped laceration along the adduction crease extending around to the dorsum of the hand. The thenar muscles were pulpified. The flexor sheath of the thumb was open, but the tendon appeared intact. The first dorsal interosseous muscle was divided and crushed. The carpo-metacarpal joint was exposed, and its capsule was practically completely divided. No nerves were visible. There were numerous lacerations on the thumb, one of them exposing the distal joint. The index finger was partially amputated through the middle of the distal phalanx. A flap of skin had been avulsed from the proximal phalanx of the index finger, but remained attached by a broad base anteriorly. The middle finger was partially amputated through the middle of the distal phalanx.

Operation consisted of the usual preparation followed by a complete débridement. Remains of the various muscles were sutured by fine catgut. All joint capsules were closed. The skin flap on the index finger was sutured back in place. The amputated ends of the index and middle fingers were débrided and left wide open. The wound in the palm was closed without drainage. There was no elevation of temperature or pulse, and all wounds were healed within three weeks without evidence of infection. A course of baking and massage was given.

Now, ten months later, all wounds are healed and there is normal motion in the fingers. Because of the loss of the thenar muscles, there is considerable impairment of adduction of the thumb. (See Figs. 1, 2 and 3.)

FIG. 8.—Photographs of the end result, and the X-ray findings on Case No. III, described in the text. It is interesting to note that there has been partial regeneration of the internal condyle and the internal malleolus.

CASE II.—W. K., nineteen years old. Admitted March 12, 1926, discharged March 20, 1926. A few minutes before admission to the New York Hospital, this patient injured his right hand, when it caught in an elevator.

Operation was performed immediately. There was almost complete amputation of the ring and little fingers as far back as the carpo-metacarpal joints. These avulsed tissues were black. The interrossei and lumbrical muscles, the flexor tendons of the middle finger, and the extensor tendons of the index and middle fingers were exposed. There was marked traumatization of the muscle tissue of the hand in this region. The cartilaginous surface of the unciform and the shaft of the middle metacarpal were exposed. The usual preparation was given and complete débridement was performed,

amputating the two inner fingers as far back as the metacarpocarpal joints. The cartilage on the articular surface of the unciform was excised. The wound was closed with a few interrupted silkworm sutures without drainage. The wound healed by primary union.

Now, eighteen months later, the scar is not tender and the patient has a very useful hand. (See Figs. 4 and 5.)

When, in addition to the wound of the soft parts, an injury to the tendons also exists, the picture becomes complicated and its solution will depend

FIG. 9.—See figure 8.

FIG. 10.—See figure 8.

more on the past experiences of the surgeon in similar instances than upon some text-book rule. It has been the writer's experience that wounds of the extensor tendons do well when sutured at the primary operation. In the great majority of instances, there is return of full function. When the injury involves the flexor tendons, an altogether different problem arises. In a previous communication (see ANNALS OF SURGERY, January, 1926), this question was discussed; what was said then, can again be repeated: "In the presence of a clean incised wound within twelve hours of the injury, imme-

diate tenorrhaphy can be done with safety, after appropriate cleansing. When the wound is ragged and dirty, obviously grossly contaminated, and the surrounding skin is covered with grime and dried blood, it is the writer's opinion that the tenorrhaphy should be deferred until the wound has healed, the immediate interference consisting solely of a general cleansing and débridement. This delay of two or three weeks has not given rise to any great increase in fibrosis or adhesion formation, nor has it rendered the secondary repair very much more difficult." (See Figs. 6 and 7.)

When the more extensive wounds involve muscles and fascia, the necessity of thorough débridement becomes imperative. Traumatized muscle is an excellent culture medium and anaërobes, always to be considered in compound injuries, grow best in such a medium. The obvious method of decreasing the possibility of this or any other infection is to remove surgically all traumatized muscle and fascia. In the very severe injuries, especially of the legs, following automobile accidents, this will often entail the sacrifice of a considerable part of the muscle tissue of an extremity. Even then, a gas bacillus infection may supervene, necessitating amputation. Conservation of limb should be the prime consideration, when possible; but it must be disregarded when conservation of life becomes the main issue. All damaged muscle and fascia is, therefore, excised by sharp dissection, the extent of this removal being gauged by the contractility and appearance of the muscle. Every effort should be made to preserve the main blood supply and all the motor nerves.

FIG. 11.—See figure 8.

Considerable importance attaches to the advisability of closing such wounds. No hard and fast rules can be made, inasmuch as the former experiences of the surgeon will be the largest factor in determining what to do. Certain generalizations can be made:

I. It seems inadvisable to bury too much suture material in an attempt to coapt various muscle and fascial planes.

II. Hæmostasis must be complete.

III. Every effort should be made to avoid tissue tension in the placing of sutures, whether deep or in the skin.

IV. Probably the majority of these wounds can be closed without drainage and a primary union will result.

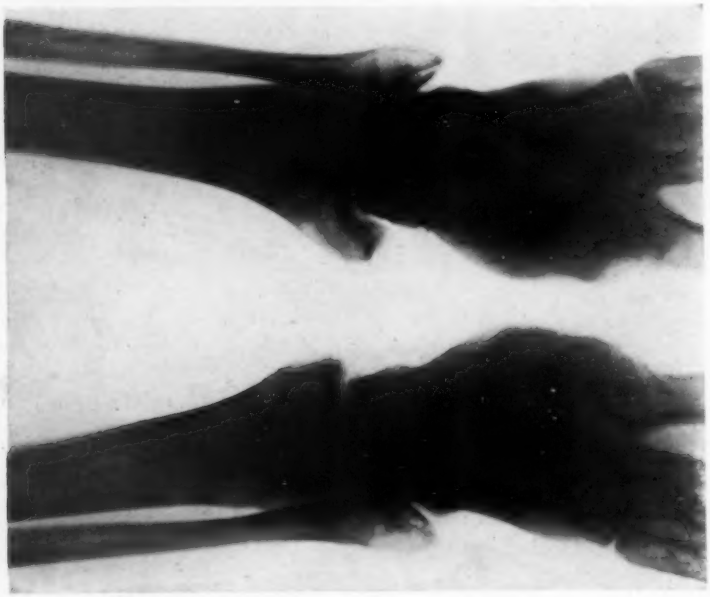


FIG. 12.—See figure 8.

V. When the wound is accompanied by marked crushing of muscle tissue, it is probably better to close the wound only partially, at the same time insuring adequate drainage.

VI. In closing the skin, the use of too many sutures should be avoided, emphasizing again the importance of preventing the tissue tension.

VII. Finally, and most important, if the history of the injury indicates

FIG. 13.—Photographs and X-rays of Case No. IV described in the text. The X-rays were taken immediately before and twenty-four hours after operation. Photograph indicates the result at the end of eighteen months.

a strong possibility of implantation of anaërobes, it is probably wiser to leave the wound wide open and later do a secondary suture.

Lacerations or compound fractures involving joints are not infrequent.

The finger-joints are more prone to such injuries and are therefore more commonly encountered. The knee, ankle and elbow-joints follow in order of frequency. A joint that has been opened by an injury does not always become infected. If one fears to close a joint because of the likelihood of infection, leaving it open is sure to invite infection. Therefore, provided

FIG. 14.—See figure 13.

FIG. 15.—See figure 13.

the capsule can be brought together, after débridement, without very great tension, immediate closure of the joint seems preferable.

Given a case with a traumatic wound opening into a joint, the following procedure is carefully carried out. This is our routine treatment for all compound injuries. After the patient is anæsthetized, the whole region involved and a wide area of surrounding skin is shaved and carefully and gently scrubbed with sterile soft brushes and tincture of green soap. The soap suds and débris are washed away with sterile saline, care being taken to prevent the washings from entering the wound. The limb is then dried with sterile towels, followed by a wash with benzine. A copious irrigation

with ether then follows. The wound and surrounding skin is then mechanically cleansed by a prolonged irrigation with sterile saline. The parts are then thoroughly dried and again flooded with ether. The entire area, skin and wound, is then painted with 3½ per cent. alcoholic solution of iodine, care being taken to keep the iodine from synovial membranes, such as in a joint or tendon sheath. The extremity is then draped. Cultures are taken

FIG. 16.—See figure 13.

FIG. 17.—See figure 13.

from the depths of the wound and also from the surrounding skin. They should be so planted as to demonstrate anaërobes, if present.

A painstaking débridement of all traumatized skin and deeper tissues is then performed. The importance of handling the tissues around such wounds with the greatest care cannot be over-emphasized. To accomplish this, instruments must be sharp, dissection must be clean and rapid, sponging must be gentle, retraction intelligent and unnecessary puttering must be avoided. The importance of obtaining absolute hæmostasis should be realized. The wound and joint are now flooded again with ether and closure is

then performed. An accurate repair of the joint capsule is very desirable and can be accomplished by the insertion of mattress sutures of chromic catgut. Frequently this cannot be done without undue tension. Under such circumstances, one or two sutures at important points will favor early repair, providing the skin is closed over it. If definite layers of fascia are discernable, they should be repaired with a few interrupted sutures. The skin is sutured with interrupted silkworm gut. If skin tension is evident, releasing incisions in the skin flaps can be made. We have found this step of considerable importance. Either before or after operation, the patient is given 1500 units of tetanis antitoxin. This is routine.

Injuries to finger joints are nearly always accompanied by laceration of the superimposed extensor tendon. This must be repaired at the same time. Ankle-joint injuries are difficult cases to repair satisfactorily and end-results are not as brilliant as with other joints. Partial closure of the joint with complete suture of the skin is all one can hope to accomplish. Injury to the articular cartilage of a joint should be disregarded at the time of operation.

FIG. 18.—Photograph and X-rays of Case No. V described in the text. The photograph indicates the wound at the end of twenty-eight days.

CASE III.—G. K., age thirty-five. Admitted February 18, 1926, discharged March 18, 1926. This patient received an injury to the right leg when it was caught in the revolving blades of a washing machine which he was repairing. He was admitted to the New York Hospital, and operated upon immediately. At operation, there were found multiple lacerations of the leg. There was a transverse laceration at the inner aspect of the knee-joint which was wide open. The internal tuberosity of the tibia had been removed in an oblique manner at the time of accident, along with about two-thirds of the internal meniscus. There was another laceration at the inner aspect of the ankle-joint exposing the joint proper. The internal malleolus was missing. There were numerous lacerations of the leg proper, exposing the tibia for a distance of three or four inches. After the usual preparation, a thorough débridement was done. The capsule of the knee-joint was repaired with chromic catgut, and all the wounds were closed without drainage. Active motion was started on the third post-operative day. The patient was allowed out of bed on the eighteenth day and discharged a month later to the out-patient department where he received a prolonged course of baking and massage.

At the present time, as indicated in the photographs, motion in both joints is normal and there is no instability. Subsequent X-rays indicate partial regeneration of the upper and lower ends of the tibia, an interesting finding. (See Figs. 8–12.)

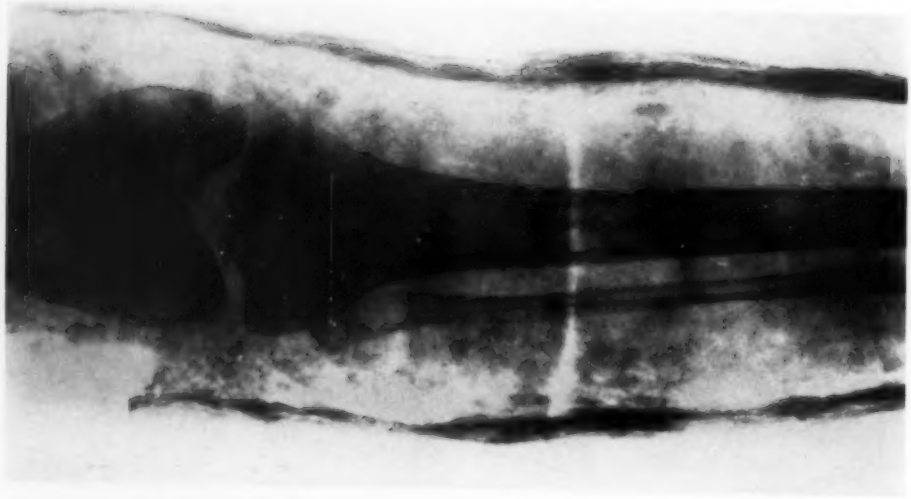


FIG. 20.—See figure 18.

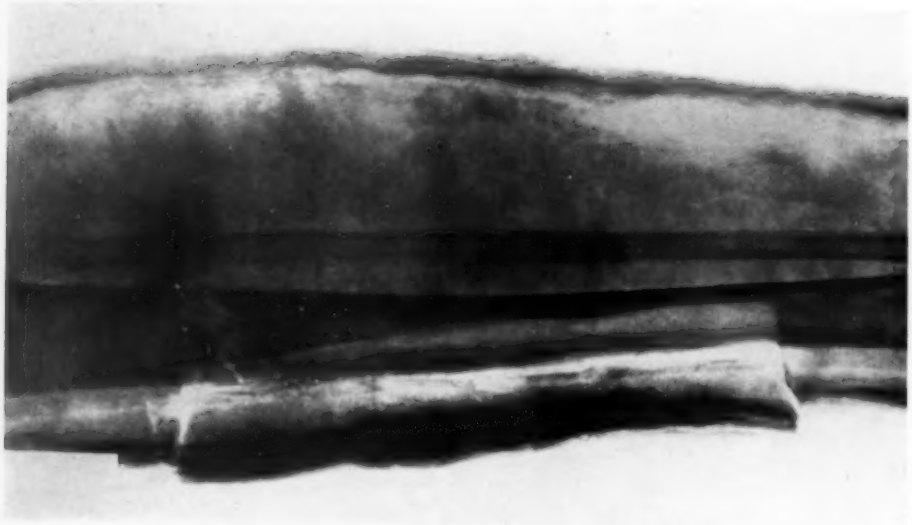


FIG. 19.—See figure 18.

CASE IV.—P. M., age five. Admitted March 22, 1926, discharged May 25, 1926. About half an hour before admission to the New York Hospital, this patient was struck by a truck, one wheel of which passed over his right leg.

Operation was performed within an hour. Along the inner side of the right knee was an irregularly shaped laceration, opening into the knee-joint. The soft parts showed considerable crushing. There was another irregular laceration over the middle of the tibia with crushing of the skin and muscles and a compound fracture of the tibia. After the usual preparation, a thorough débridement was performed. The knee-joint capsule was closed with interrupted chromic catgut, and the skin sutured with interrupted silkworm gut without drainage. The leg wound was treated in the same way after a large hæmatoma was excised from the muscle planes and all traumatized muscle had been removed. The fracture was reduced and held in position by a circular strand of kangaroo tendon. The leg from toes to mid-thigh was encased in a plaster cast. Convalescence was uneventful. The wounds were inspected through windows cut in the cast and were soon healed by primary union. About four weeks later, the patient was taken to the operating room and a posterior moulded splint applied, placing the knee at 45° flexion. This patient received no physiotherapy.

End-result is indicated in accompanying photographs. (See Figs. 13–17.)

FIG. 21.—Case No. VII described in the text. X-rays before and after operation. Photographs indicate the granulating wound before and after skin graft.

The period of immobilization following operation varies with each case, depending upon the extent of the injury, the extent of closure of the capsule, and the presence of associated injuries, such as fractures. In general, the earlier active motion is started, the better will be the end-result. This applies particularly to the knee, elbow and ankle. Finger-joints with tendon suture require longer immobilization, approximately twelve to fourteen days. In uncomplicated ankle, knee or elbow injuries, active motion should be started on the second or third post-operative day. The range of motion will increase from day to day. Forcible attempts at passive motion should be strictly avoided. Weight bearing is permissible after eight to ten weeks.

COMPOUND FRACTURES AND DISLOCATIONS

All fractures compounded from without inward should be subjected to the operation of débridement following the cleansing above outlined. We feel that this admits of no argument. The majority of fractures compounded from within outward can be treated as simple fractures with very little, if any, danger. If, as occasionally occurs, the soft part wound is larger than

the usual puncture wound and a large section of the fractured end has protruded, then operation is indicated.

Very frequently these patients, upon admission to the hospital, are in shock. This must be treated before operation is attempted, the indication for proceeding being an improvement in the quality and rate of the pulse and elevation of the systolic blood-pressure to 100 mm. or over. Frequent use

FIG. 22.—See figure 21.

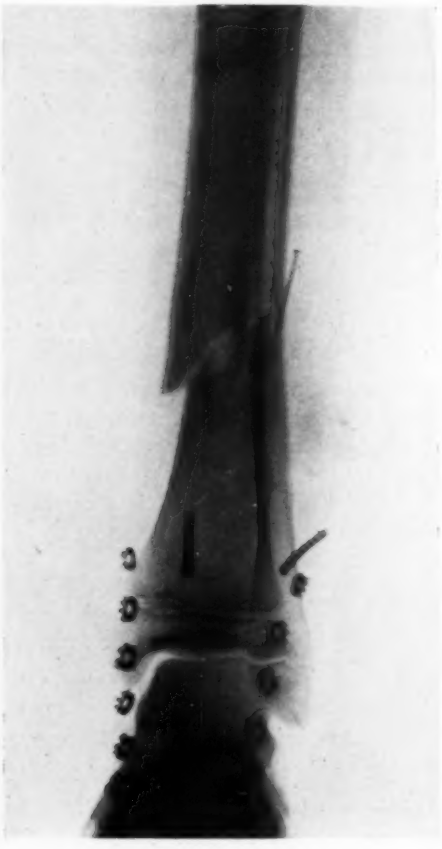


FIG. 23.—See figure 21.

has been made of the intravenous glucose insulin therapy, recommended by Fisher, with fairly satisfactory results. It is often necessary to wait three or four hours before operation can be attempted.

At operation, a very thorough débridement is performed. Adequate exposure is obtained by making a longitudinal incision over the site of injury. The formation of hæmatomata between and in muscles is a more frequent occurrence with compound fractures than with any other compound injury. These must be evacuated, as they form the best culture media for anaërobic organisms. All loose unattached bone fragments should be removed. It is inadvisible to remove too much periosteum. The ends of the bone should be removed with rongeurs and so fashioned as to form a mortise, whenever

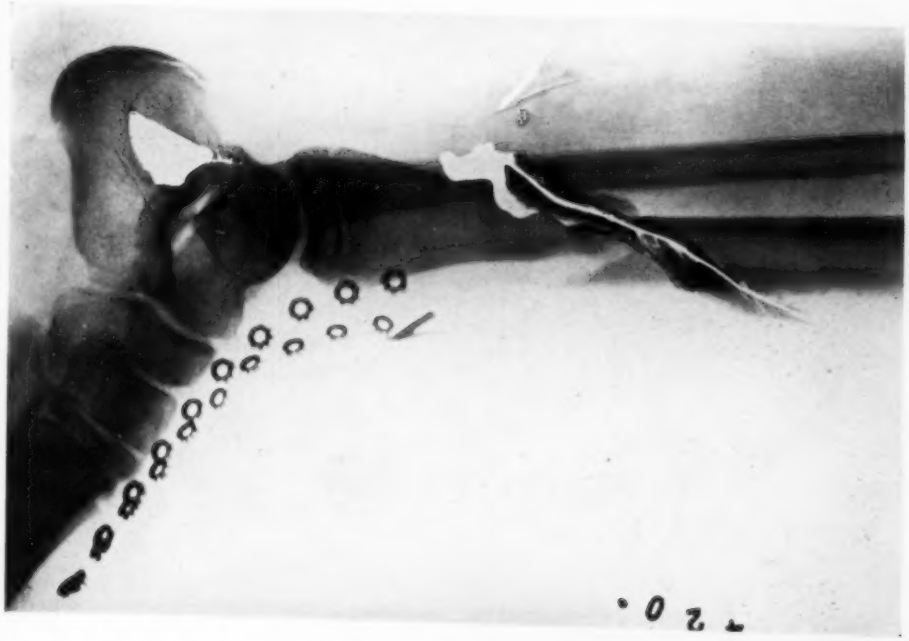


FIG. 24.—See figure 21.

FIG. 25.—See figure 21.

possible. Transverse fractures, when reduced, usually lock satisfactorily and require no internal fixation. Oblique and spiral fractures, because of a tendency to displacement of the fragments, require some form of fixation. Our limited experience with Lane and Sherman plates has been distinctly unsatisfactory in this type of case. Main reliance has been placed upon the use of kangaroo tendon sutures placed around the bone and, also, obliquely through the bone through drill holes. This method has been particularly satisfactory in compound fractures of the tibia, humerus, radius and ulna. We have always been reluctant to insert foreign material in the form of metal plates and screws, in the treatment of compound fractures. Occasionally, it is necessary to do so, as in certain types of femur injuries and in other fractures with loss of substance. However, the majority of the femur fractures have been treated by débridement followed by traction and suspension.

FIG. 26.—See figure 21.

CASE V.—R. B., eighteen years old. Admitted December 8, 1926, discharged February 12, 1927. One hour before admission to the New York Hospital, this patient was hit by a taxicab, the bumper of which pinned the patient's right leg against an elevator pillar. Physical examination showed considerable shock, which was controlled by an infusion of 500 c.c. of glucose and 20 units of insulin, given according to the Fisher method.

Operation was performed four hours after admission. The usual preparation was given. There were two transverse lacerated wounds over the front of the tibia through which were seen the fractured ends of the tibia. A longitudinal incision was made connecting the two lacerations. There was considerable traumatized muscle and fascia. All traumatized tissue was carefully excised, including several small loose fragments of bone. To maintain reduction of the fracture, four drill holes were made and two kangaroo tendon structures were placed at right angles to each other. The wounds were then closed without drainage, using interrupted chromic for the skin. Circular cast was applied. The wound was inspected daily through a window cut in the cast, and it healed by primary union. Temperature and pulse remained normal. On January 17, on removal of the cast, on the lateral aspect of the leg, was seen an area 4 x 2½ inches which was covered with slough. This apparently marked the point where con-

siderable trauma had been received at the time of accident. The slough was removed and the wound was dakinized. On January 26, numerous small deep grafts were applied. Upon discharge from the hospital, all wounds were healed.

Now, one year later, union is firm, there is no shortening, and no limp. (See Figs. 18–20.)

CASE VI.—J. B., seven years of age. Admitted October 30, 1926, discharged November 27, 1926. While sitting in the door of a dumbwaiter shaft, this patient was injured when the rope broke and the dumbwaiter fell two stories. The force of the impact was received on the right leg. The patient was admitted to the Second Surgical Division of the New York Hospital soon afterwards. Examination showed moderate shock. At the middle of the right tibia was an irregularly shaped longitudinal wound, four inches in length, through which the ends of the fractured tibia protruded. There was considerable crushing of the muscles and fascia.

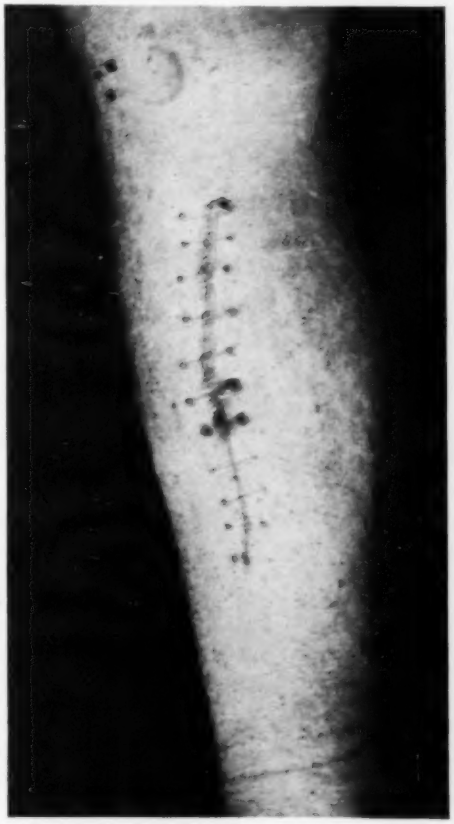


FIG. 27.—Case No. VI described in the text. The photograph was taken eighteen days after the operation.

At operation, performed two hours later, the usual preparation was given. An irregular transverse fracture of the tibia with considerable crushing of the extensor muscles of the foot was disclosed. Periosteum of the upper fragments was denuded for a distance of about three inches. The entire wound was débrided, including the ends of the bone. The fracture was reduced and the reduction maintained by kangaroo tendon sutures placed obliquely through drill holes. No deep sutures. Interrupted chromic catgut for the skin. Circular plaster cast from toes to mid-thigh was then applied. On November 2, the wound was inspected through a window cut in the cast, and found to be clean. Temperature and pulse remained normal, and convalescence was uneventful. The wound healed by primary union.

Now, one year later, there is firm union, no shortening, and no limp. (See Figs. 27 and 28.)

CASE VII.—H. G., age sixteen years. Admitted November 8, 1926, discharged January 6, 1927. This patient was knocked down by a taxicab, and he received an injury to the left leg when one of the wheels passed over it. He was admitted to the New York Hospital soon afterward, and presented the following:

There was a transverse lacerated wound over the front of the leg at the junction of the middle and lower thirds which measured 1½ inches. The surrounding skin was moderately traumatized. The fractured tibia was visible in the centre of the wound.

At operation, performed one and a half hours after admission, the usual preparation was carried out. A longitudinal incision 8 inches in length was made. A large dissecting hæmatoma was seen along the front of the tibia beneath the periosteum. This extended to within two inches below the knee. There was considerable crushing of the posterior tibial muscles. The wound was thoroughly débrided, the hæmatoma was

evacuated, and all traumatized muscle was excised. Fracture was reduced and locked. One kangaroo suture was placed about the tibia at the site of fracture. Interrupted chromic sutures for the skin. No drainage. Releasing incisions were made on each side of the incision because of the apparent trauma to the skin. It was thought that the skin over this region would probably slough. A window was cut in the cast, and the wound was inspected daily. The temperature and pulse remained normal. The skin which had

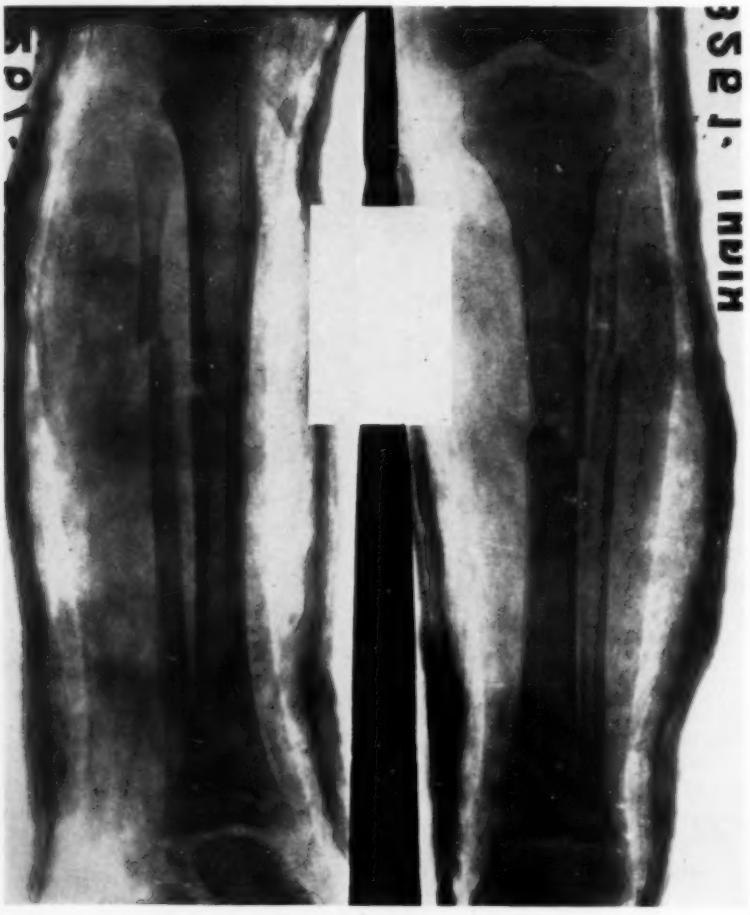


FIG. 28.—See figure 27.

been traumatized at the time of accident, sloughed, leaving an area 7 x 3 inches. This was dakinized, and on December 20, small, deep grafts were applied. The wound was completely healed two weeks later, and the patient was discharged from the hospital.

Now, one year later, union is firm, the scar does not break down, there is no shortening or limp. (See Figs. 21–26.)

The majority of these wounds can be closed without drainage. If, however, the history of the injury indicates a strong possibility of contamination with anaërobic organisms and there has been considerable soft part trauma, then discretion should be the better part of valor and the wound should be left wide open, to be dakinized by the Carrel-Dakin technic. A secondary

suture or skin grafting can be done at a later date. If these facts are taken into consideration, indiscriminate closure of all wounds will be avoided and the incidence of gas gangrene will decline.

FIG. 29.—Case No. VIII reported in the text. X-rays indicate the position of the fragments soon after operation with the Dakin tubes in place and the result at the end of twenty months. The photographs show the thin scar at the site of injury and the method used in applying a pedicle skin flap in three stages and the result at the end of sixteen months.

CASE VIII.—D. U., age four. Admitted September 12, 1925, discharged January 2, 1926. A half hour before admission to the New York Hospital, this patient was run over by a taxicab, two wheels passing over his left leg. On questioning, it was found that the street where the accident occurred was plentifully covered with manure; in fact, at the time of operation, numerous particles were seen in the wound. Operation, performed immediately, showed a compound fracture of the left tibia and fibula with avulsion of the skin over a distance measuring two square inches. After the usual preparation, a débridement was performed, the fracture was reduced, and the wound was left wide open. Convalescence was uneventful, except for the fact that on two occasions it was necessary to reduce the fragments at the site of fracture. The wound healed by granulation, after thorough dakinization, and was soon covered by a thin layer of epithelium, intimately attached to the bone. After discharge from the hospital, it was noticed that the slightest trauma produced an ulceration in the scar. One year later the patient was readmitted to the hospital, and a pedunculated skin flap, taken from back of other leg, applied after excision of scar. This was done in three stages. Photographs indicate manner in which this was accomplished.

FIG. 30.—See figure 29.

At the present time, two years after the accident, there is no shortening, and there has been no evidence of ulceration at any time in the grafted skin. (See Figs. 29–36.)

Because of the extensive musculature and the consequent greater soft part crushing, compound fractures of the femur should rarely be closed without drainage. Gas gangrene starting in this region carries a high mortality. We have always left these wounds wide open, followed by dakini-

zation and, often, by secondary suture. In the vast majority of compound fractures, it is rarely necessary to insert deep sutures. The tissues fall together after the fracture is reduced. Again, great emphasis must be placed upon the necessity of obtaining absolute hæmostasis.

FIG. 31.—See figure 29.

External fixation in nearly all uncomplicated fractures of the arm, leg or forearm, can be obtained by the application of a circular plaster cast. A window is immediately cut in the cast, exposing the operative wound. This is inspected daily for the slightest evidence of gas bacillus or other infection. A careful watch is kept of the temperature and pulse rate. A sudden elevation of both is of serious prognostic significance, indicating usually beginning gas gangrene. In

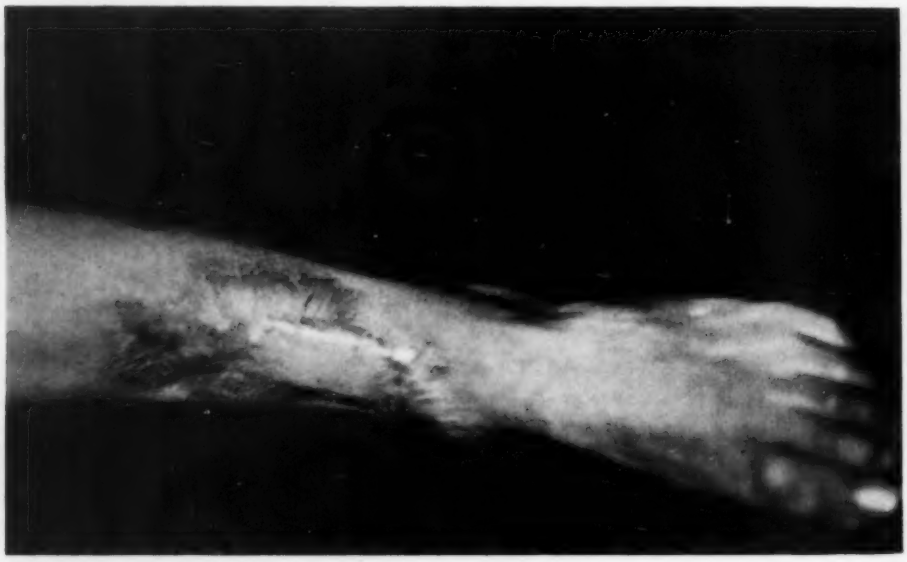


FIG. 32.—See figure 29.

femur injuries and others not sutured, or with loss of considerable skin, traction and suspension is indicated. Dressing of wounds is thereby greatly

simplified. The subsequent treatment of these cases is dependent upon the type of injury, and follows the same general rules observed in the treatment of simple fractures.

WOUNDS WITH LOSS OF SKIN

In our work on this general subject, the problems involved in the treatment of wounds with loss of large skin areas have probably been of greatest

FIG. 33.—See figure 29.

FIG. 34.—See figure 29.

interest. No two cases exhibit similar injuries. Each presents a separate individual problem which must be solved according to the existing conditions. It is for this reason that no hard and fast rules can be made to govern treatment.

In wounds of lesser magnitude, without associated bone or other injury, it is frequently possible to undermine the skin edges, after thorough débridement, and bring about satisfactory apposition. In doing so, it may become necessary to shift adjacent skin areas by a plastic operation, according to the now well-known principles governing such procedures. When, however, after careful study, it is seen that such an operation would jeopardize the vitality of the adjacent skin, other methods present themselves for consideration.

FIG. 36.—See figure 29.

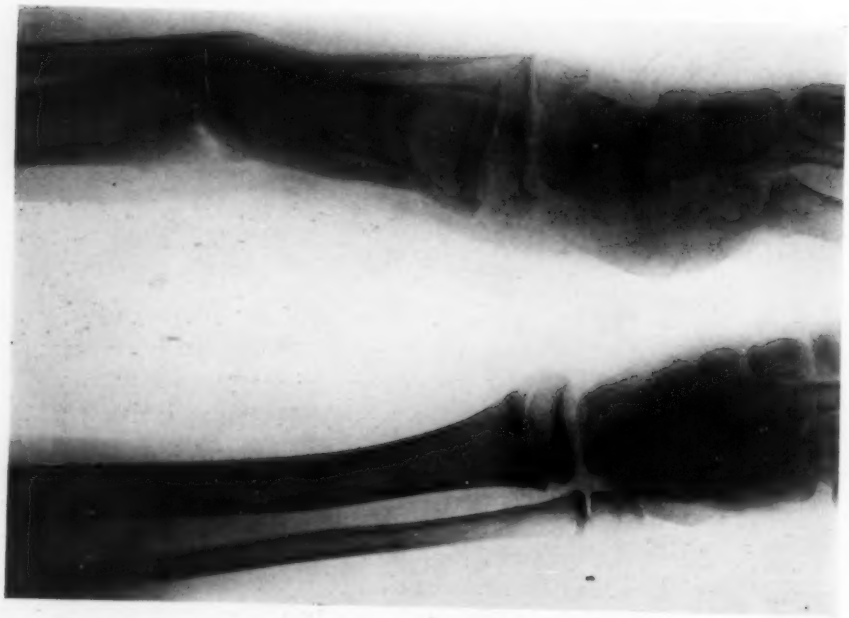


FIG. 35.—See figure 29.

In such wounds of the extremities without associated bone injury, one of four procedures may be utilized, according to the local indications:

I. It may be feasible to perform a débridement and apply immediately a

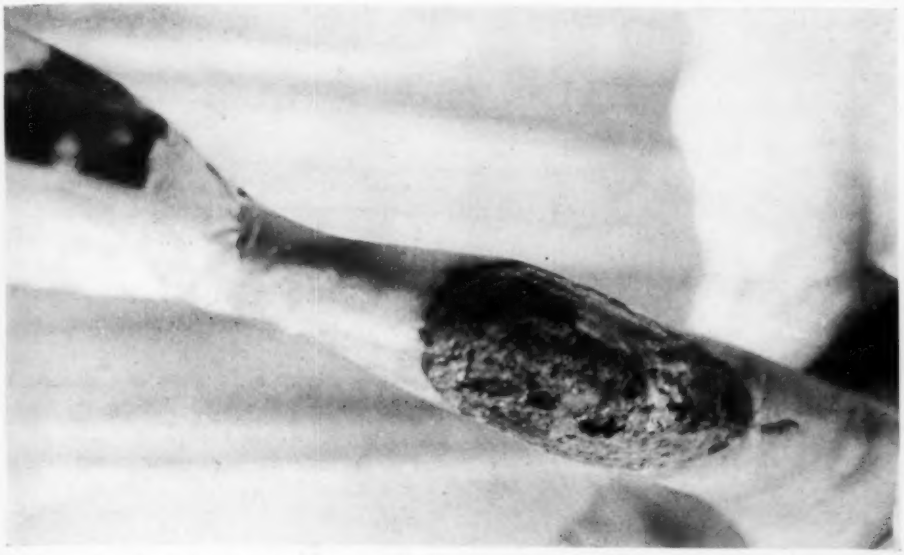


FIG. 37.—Case No. X described in the text, indicating the appearance of the wound five days after operation.

pedunculated flap from an adjacent or distant region of the body. This method would seem to apply particularly to wounds of the hand and wrist.

FIG. 38.—Case No. X, one and one-half years later.

Inserting the hand beneath a skin flap on the abdomen at the primary operation is a proper and justifiable procedure, providing there are no contraindications locally in the type and extent of the hand wound.

CASE IX.—D. C., age twenty-four years. Admitted March 16, 1925, discharged June 1, 1925. Patient injured his right hand just before admission, when it became caught in a macaroni rolling machine.

Operation was performed forty-five minutes after admission. It was seen that all the skin and subcutaneous tissues from the wrist to the middle phalanges of all the fingers had been turned inside out as though it were a glove. There was considerable trauma to these tissues. The little finger was practically completely amputated. Operation consisted in the usual preparation followed by a complete débridement. The flap was turned back and sutured to the skin at the wrist with two silkworm gut sutures. Incisions were made in the web spaces and the whole hand was extensively drained. X-rays later disclosed fractures of the first, second, and third metacarpal bones, and the proximal phalanges of the index and middle fingers. As was expected, the skin sloughed, as indicated in the photographs. After the wounds had been treated by the Carrel-Dakin technic, it was decided to apply a pedunculated skin flap from the abdomen. On April 14, the first stage was done. The hand was placed beneath a skin flap broad enough to cover the wound on the dorsum of the hand. A plaster cast was applied immobilizing the arm to the side. On April 30, the upper attachment of the flap was divided. Circulation was good. The lower pedicle was extended further, the purpose of this being to roll the hand in such a way so that the flap would unite to the wound on the front of the hand in one continuous piece. The pedicle was further extended two inches and the hand was rolled upward. On May 6, the third stage was performed, when again the lower pedicle was extended for 1½ inches. At the fourth stage, the lower pedicle was divided and the abdominal wound closed by a plastic undermining of the skin. The flap was then rolled around the front of the hand so as to cover the deficiency of the palm. One suture used. On May 26, the flap was revised and made to conform to the shape of the wound in the palm of the hand. Excess fat was excised at this operation. These various stages are indicated in the accompanying photographs. (See Figs. 44–53.)

FIG. 39.—Case No. XI described in the text. The X-rays indicate the fracture a few days after operation, and show the method described in the text, of applying a plaster boot and a cast above the fracture, incorporating in both, the ends of curved metal rods, thereby immobilizing the fracture, and allowing easy access to the wound. The other X-rays and photographs indicate the result at the end of two years.

While the patient was being treated in the dispensary, it was noticed that there was marked limitation of flexion in the metacarpo-phalangeal joints of the middle and ring fingers. The flap on the dorsum of the hand appeared too thick. The patient was therefore readmitted September 16, 1925, and an operation was performed. This consisted of excision of the scar in the region of the metacarpo-phalangeal joints, freeing of the extensor tendons, and posterior capsulotomy of the metacarpo-phalangeal joints of the

ring and middle fingers. The excess fat in the graft along the inner side of the hand was excised. The fingers were put up in acute flexion. The patient was discharged September 21, with the wound healed, showing a marked improvement in flexion of the ring and middle fingers. To reduce the thickness of the flap on the outer side of the hand, another operation was performed on January 21, 1926. On this date, excess fat and skin was excised.

At the present time, two and a half years following the accident, there is practically normal motion in all of the fingers, the hand, cosmetically, is quite presentable, and the skin has acquired sensation. The patient has returned to his former occupation.

II. For the majority of wounds, probably the most logical procedure is a thorough débridement followed immediately by the application of Thiersch grafts, as was recently suggested by H. H. M. Lyle. By this operation, one hastens convalescence, and, most important of all, diminishes to an astonishing extent, the degree of fibrosis in the subcutaneous tissues which always follows the slower process of healing by granulation and epithelialization from the sides. At a later late, if thicker skin is necessary, a pedunculated flap can be applied at one's leisure. We have often been impressed by the value of this method.

FIG. 40.—See figure 39.

III. If the wound is accompanied by extensive crushing and devitalization of tissue, it is probably wiser not to attempt immediate skin grafting, contenting oneself with as thorough a débridement as possible. Intensive dakinization subsequently, followed by the application of Thiersch or small, deep grafts as soon as the appearance and bacteriology of the wound permits, forms the basis of the additional treatment.

CASE X.—F. B., age fifty. Admitted March 22, 1926, discharged April 23, 1926. An hour before admission, the patient caught his right arm in the gears of a washing machine. The skin over the posterior aspect over the elbow, forearm, and arm was avulsed.

At operation, it was seen that the skin and subcutaneous tissues over an area measuring 9 x 3½ inches had been avulsed. The tip of the olecranon process of the ulna was fractured and the elbow-joint was visible. There was no nerve injury. A large amount of dirt and grease had been ground into the wound. Operation consisted of the usual preparation followed by thorough débridement. The arm was put up in extension in a Thomas splint and dakinized. On April 14, 1926, the area was covered with half thickness skin grafts taken from the front of the thigh. The elbow was put up in acute flexion. Convalescence was uneventful.

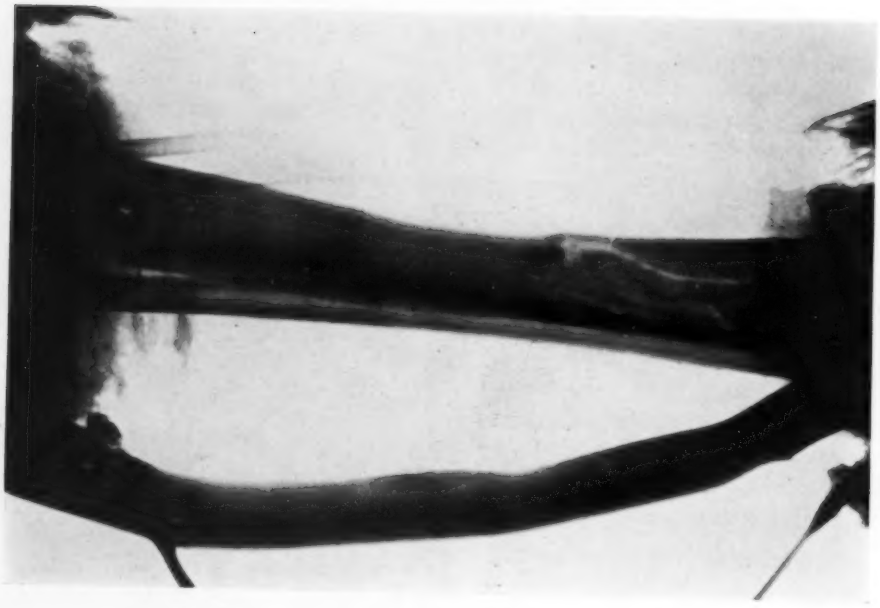


FIG. 42.—See figure 39.

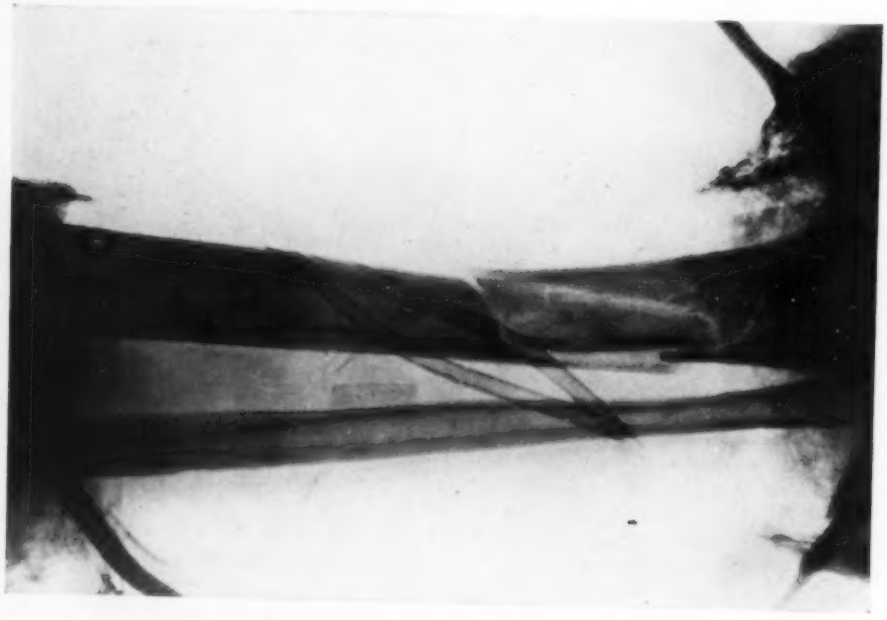


FIG. 41.—See figure 39.

Now, one and a half years later, the wound is completely healed, and there is normal motion in the elbow-joint. The patient has returned to his former occupation. (See Figs. 37 and 38.)

IV. It may occasionally be possible to apply a free, full-thickness skin graft, according to the technic worked out by Blair, Davis, McWilliams and others, after thorough débridement. Our experience in this form of skin grafting for traumatic wounds has been very limited. Theoretically, it is a method open to many objections for the particular type of case under consideration and carries with it too much risk as to the viability of the graft, to warrant its recommendation.

FIG. 43.—See figure 39.

When, in addition to loss of skin, there is an associated bone injury, it is doubtful whether any form of skin grafting should be attempted at the primary operation. In the majority of these cases, the bone lies exposed in the wound and grafts placed over such soil will not take. Therefore, a thorough débridement with reduction of the fracture, should constitute the extent of the primary procedure. The wound is dakinized subsequently and, when the area has become filled in with granulations, skin grafts are applied. In fractures of the tibia under such conditions, an excellent method of simplifying dressings consists in placing a plaster boot on the foot and ankle and a plaster cast about the leg, knee and thigh, leaving the injured area uncovered for the entire circumference. Strong curved metal rods are incorporated in the boot and the cast above, thereby at the same time immobilizing the fracture and allowing easy access to the wound.

CASE XI.—P. McA., age fifty-one. Admitted July 22, 1925, discharged October 19, 1925. While getting off a tug, this patient caught his right leg between the bow of the tug and a post on the dock, receiving a crushing injury. He was admitted to the New York Hospital in considerable shock, which was combated by an intravenous injection of glucose and insulin. At operation, there was found a two-inch transverse lacerated

FIG. 45.—See figure 44.

FIG. 44.—Case No. IX described in the text. The photographs indicate the appearance of the hand on the sixteenth day following the injury and the method used in covering the wound with a pedunculated skin flap from the abdomen. Unfortunately, photographs were not taken after the final stage. At the present time, the flap is much thinner than the photographs indicate, and there is normal motion in the finger joints.

wound along the inner side of the right leg at the junction of the middle and lower thirds, with two similar wounds anteriorly, and one on the outer side. The skin for a distance of six inches around this area was obviously dead. After exposure, it was found that all the muscles and subcutaneous tissues along the inner and posterior aspects were severely crushed. The posterior tibial vessels were found divided. The nerves were intact. The tibia was fractured in a comminuted manner with long anterior and posterior fragments. The anterior tibial vessels appeared to be intact. After the usual preparation, the entire area was débrided, including the traumatized skin. This left a gap, measuring 12 x 7 cm. A strand of kangaroo tendon was placed around the fracture. The wound was left wide open and a plaster boot applied with a circular plaster cast about the upper leg, knee and thigh, incorporating the curved metal rods in the plaster, as described in the text. The convalescence was uneventful. The wound was dakinized and the circulation of the foot remained good. Five weeks after operation, it was found that union was firm, but that there was a granulating area along the inner and posterior aspect of the leg, measuring 6½ x 12 cm. This area was subsequently covered by a pedunculated skin flap taken from the back of the opposite leg. This procedure was accomplished in three stages. The accompanying photographs indicate the end-result at the end of two years. (See Figs. 39–43.)

FIG. 46.—See figure 44.

The type of skin transplantation which is done later must be carefully considered. Fractures of the tibia with loss of skin should always be covered with a pedicled skin flap. Such wounds when covered with Thiersch or Davis grafts ulcerate on the slightest trauma, when weight bearing is reëstablished. With thicker skin flaps, such is not the case. In other situations where the bone does not lie subcutaneously, Thiersch or small, deep grafts suffice, as a rule.

FIG. 48.—See figure 44.

FIG. 47.—See figure 44.

AMPUTATIONS

It is not within the scope of this paper to go into a detailed study of the subject of amputations. It is desired only to emphasize certain general principles pertaining to the subject of amputations for traumatic lesions.

In general, every attempt should be made to preserve a limb, providing this can be done with a clear understanding of the possibilities involved. Some will subsequently come to secondary amputation, but the not infrequent case will come through with a serviceable limb. It is doubtful whether the adoption of this policy has resulted in an increased mortality. At least, a study of our cases does not indicate this.

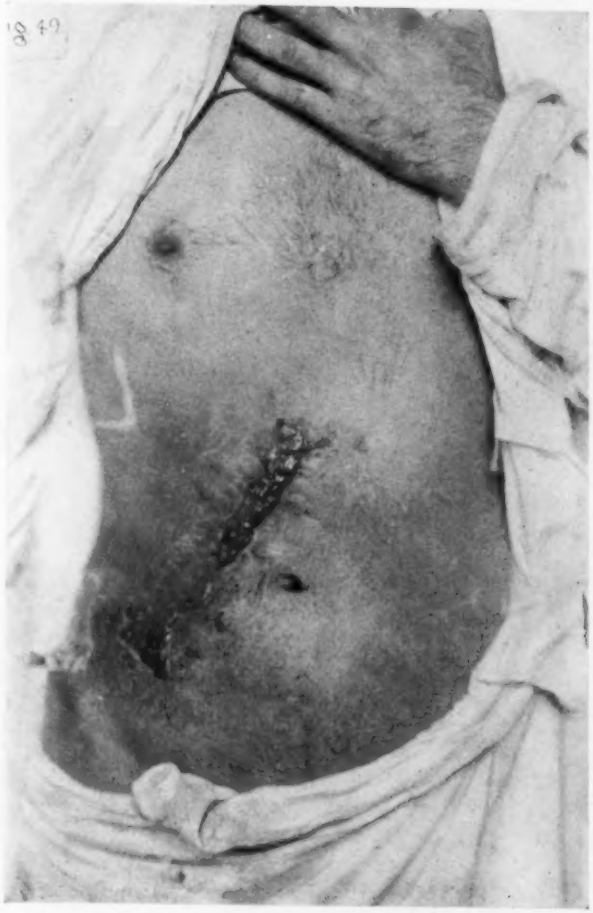


FIG. 49.—See figure 44.

Because of the local conditions present, primary amputations often become necessary:

I. When the entire blood supply distal to the injury has been cut off by the trauma, amputation is indicated. The absence of palpable pulses, the color of the extremity and the surface temperature variations, as compared with the sound side, will guide the surgeon in determining his course.

II. Not infrequently one encounters a case where there has been an avulsion of the skin and subcutaneous tissues of an entire leg or forearm. Such an injury is usually accompanied by crushing of the muscles and occasionally by fractures. It is very doubtful whether any attempt should be made to preserve such a limb. The extent and severity of the trauma will be the guiding factors.

III. Irreparable crushing of bone, always accompanied by crushing of soft parts, calls for amputation. The injuries produced by heavy vehicles constitute the bulk of the cases making up this group.

FIG. 51.—See figure 44.

FIG. 50.—See figure 44.

The site of amputation will depend on the situation and extent of the injury, the proximity of neighboring joints and a consideration of the subsequent use of an artificial limb. In general, it may be said that amputation should be performed in such a way as to leave a most serviceable stump, whether this be for an artificial limb, a prosthesis or for cosmetic reasons. It would, therefore, be inadvisable to amputate a leg, for instance, just below the knee-joint. A lower thigh amputation would be more serviceable to the patient from the standpoint of an artificial limb. In some varieties of amputations, every attempt should be made to preserve as much tissue as possible. This applies particularly to upper extremity injuries, especially the hand. Unless hopelessly crushed, every effort should be made to preserve part of the hand. If the thumb alone can be saved, a great deal will be accomplished. With an intact thumb, it is surprising what can be done, in the line of reconstruction work, later, with the remains of the other digits.

FIG. 52.—See figure 44.

FIG. 53.—See figure 44.

As to the technic of amputation, only one or two general principles need be emphasized. It seems wholly immaterial what type of flaps is fashioned, provided sufficient tissue is left to make a well-padded stump. It is essential to divide the bone considerably higher up than the soft part amputation and to section all nerves at some distance above the end of the stump to prevent later stump neuromata. The most important question to be decided pertains to the advisability of suturing such amputation wounds at operation. Although amputation is performed through normal and

relatively clean tissue, the close proximity of the wound with its tissue trauma and implantation of bacteria makes immediate closure a step demanding serious consideration. It must be remembered that, as most of these injuries are caused by motor vehicles on public thoroughfares, the likelihood of a general contamination with anaërobic bacteria must be greatly increased. Undoubtedly, a number will heal without difficulty after primary suture. But, a few unfortunate experiences, involving the development of gas bacillus infection in the sutured stump requiring reamputation, in spite of careful skin preparation, have convinced the writer that, as a general rule, it is much safer to leave the wound wide open, after fashioning long flaps, sectioning the bone and nerves high up and carefully ligating all bleeding points. When it is evident, at a later date, that there is no infection, the application of a few sterile adhesive straps, carefully coapting the skin edges of the flaps, will bring about rapid and satisfactory healing. It is by adopting this safe procedure that it will be possible to decrease the incidence of the greatest and most serious complication of compound injuries of the extremities, namely, gas gangrene.

HEAD INJURIES IN CHILDREN*

AN ANALYSIS OF 331 CASES WITH ESPECIAL REFERENCE TO END RESULTS

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This paper is a report of a study of 331 cases of injuries to the head in children under thirteen years of age, admitted to the Children's Surgical Service of Bellevue Hospital during the years 1921 to 1926 inclusive.

Though the condition of the patients, on admission and during their hospital stay, has been studied, an additional analysis has been made of those cases which were followed through the Return Clinic, in an attempt to find out the end results of their injuries.

As the seriousness of any head injury depends in direct relation to the amount of damage produced to the cranial contents and not to the extent of the fracture of the skull, it has seemed wise to include in this analysis all cases which showed any signs of intra-cranial injury. Therefore of the 331 cases reported there were 214 discharged with the diagnosis of fracture of the skull and 117 with a diagnosis of intra-cranial injury without fracture of the skull. A diagnosis of fracture of the skull was made in those cases showing the classical clinical symptoms of the condition or where an X-ray examination demonstrated a loss of continuity in the bones of the skull. There is a probability that some of those cases placed in the group of intra-cranial injury without fracture of the skull, in reality had a fracture without producing clinical symptoms or being demonstrated by the X-ray.

Of the 331 patients admitted to the hospital, thirty-eight died, all in the fractured skull group. Of those cases that lived to be discharged from the hospital, 234 were followed up through the Return Clinic, for periods varying from two months to five years; 151 of these cases were of the fractured skull group and eighty-three were in the group of intra-cranial injury without fracture of the skull. All of the cases returning were seen by members of the staff of the Children's Surgical Service, some were sent for special examination to the Departments of Neurology or Psychiatry, and at times the teachers of these children were questioned as to the child's condition before and after the injury.

In the results reported, any patient complaining of symptoms, referable to their injury, at any visit to the Return Clinic, were placed amongst those showing sequelæ, even though they may have been seen only six weeks or two months after they had left the hospital.

The ages of the children varied from under one year to thirteen years of age. There was little difference between the number of cases at different ages,

* Presented before the Section of Neurology and Psychiatry, New York Academy of Medicine, December 13, 1927.

after the third year of life. Seventy-eight per cent. of the patients were boys. In 123 cases the injury was the result of a collision with a vehicle, usually an automobile; in eighty-six the result of a high fall (a distance of ten feet or more); in thirty-three a short fall produced the injury; twelve were struck on the head by some object and in seventy-five of the cases the histories did not state what caused the injury. However, the prognosis of the seriousness of the condition can not be made from the type of accident producing it, as shown in the case of two children, of three and five years, respectively, who fell from fifth story windows, in whom there were no apparent injuries when admitted to the hospital, while a boy, of seven years of age, falling from the second step on to the sidewalk was for many days unconscious, suffering from an injury to the brain, the result of a fracture of the middle fossa of the skull.

In classifying these cases, those patients showing a period of unconsciousness, shortly followed by a stage of reaction, in which they vomited, and where there were none of the local clinical signs of fractured skull, together with a report of a negative X-ray examination, were placed in the group of intra-cranial injuries without fracture of the skull.

In the fracture of the skull group of cases, the diagnosis was established by seeing or palpating the fracture as in the case of depressed or compound fractures; by the local clinical signs the result of injury to blood-vessels, cranial nerves or to the covering of the brain; or by positive findings on X-ray examination.

To attempt to make an accurate classification of the location of the fracture is impossible in a group of clinical cases. Fractures of the base usually extend into the vault and likewise those of the vault frequently run to the base. Examination at necropsy is the only accurate means of obtaining the knowledge sought. However, from data obtained from 175 histories concerning the clinical symptoms presented, together with the X-ray findings, the following classification was compiled in an attempt to place the location of the fractures for this series:

	Per cent.	
Anterior fossa	21	
Anterior and middle fossa	8	
Middle fossa	25	
Middle and posterior fossa	7	
Posterior fossa	12	
All three fossæ	1	
Vault	26	(Depressed 7%)

The diagnosis of fracture of the skull was frequently made only by means of the X-ray. Thus in 123 cases in which the reports of the X-ray examination were positive, fifty-seven showed none of the classical symptoms of fracture of the skull, though thirty-six did have hæmatomas beneath the scalp over the site of the fracture. In six of the histories of the remaining twenty-one cases it was definitely stated that the individual had not had a period of unconsciousness following injury. Thus, in these six cases, the

diagnosis of fracture of the skull was made entirely on the history of injury, and a positive finding on X-ray examination.

In 21 per cent. of these cases of fracture of the skull, in which there was a record upon the chart of a röntgenogram examination, the report was negative for fracture, though the clinical symptoms were present. Undoubtedly in most, if not all, of these cases a positive report for the examination could have been obtained, if enough exposures had been secured through sufficient plains of the skull.

In the histories of forty-eight of the fractures of the skull group, there were no X-ray reports. However, thirty of these patients died and were probably too sick to be moved for the examination.

If for the sake of discussion, these 214 cases of fracture of the skull be divided into groups, according to the severity of their symptoms, as shown at the time of admission to the hospital; that is, those showing little, if any, signs of cerebral injury being classified as mild, those showing a period of unconsciousness lasting only a few hours and soon reacting as moderate, and those in deep coma, irritable or having general convulsions being classified as grave; there would be forty in the mild, ninety-eight in the moderate and seventy-six in the grave groups. Most of the cases in the mild group were those with fractures of the vault, both fissured and depressed, while practically all those classified as grave gave clinical signs of extensive fractures of the base, by far the greater number involving the middle fossa of the skull.

The extent of the fracture line in the vault, in cases of linear fracture, did not necessarily bear a direct relation to the severity of the cerebral injury as shown by the following cases:

Case I.—A girl, nine years of age, was admitted on May 15, 1923, having been knocked down by an automobile and striking her head against the curbing. There was a slight abrasion over the right temporal region. She was conscious and orientated. There was a small hæmatoma over the right parietal region, otherwise nothing was found on examination.

The report from the X-ray was: "That there is a fracture extending completely around the skull. The line of fracture beginning at the right side of the frontal bone goes backward to the parietal and extends around to the left side. There is evidence of increased intra-cranial pressure." This child was last seen in the Return Clinic in March, 1926, three years after the accident, having never suffered from any symptoms referable to it.

Case II.—A boy, seven years of age, was admitted to the hospital on May 23, 1924, having fallen from a fire-escape just prior to admission. He was unconscious when picked up. He vomited once. On examination he was found to be slightly drowsy but could answer questions. There was a small swelling in the left parietal region of the skull, which was soft and tender. There were no other symptoms found.

The X-ray department reported: "Comminuted fracture of the skull; one line of the fracture running from the middle fossa backward along the parietal bone bifurcating in the occipital region; one line running upward into the parietal and the other running downward and around the occipital to the right side. Marked increased intra-cranial pressure."

This boy was followed for one and a half years and never showed any symptoms resulting from the accident.

CASE III.—A girl, five years of age, just before admission, had fallen from a fire-escape, a distance of four stories, on to a patch of earth. There was no loss of consciousness. It was thought she struck a clothes line in the fall. She vomited several times.

Examination showed a large swelling of the forehead more marked on the right side. This apparently was a hæmatoma. Later she developed ecchymosis under both eyelids. The X-ray department reported: "A fracture of the fronto-parietal bones, the line of fracture running transversely beginning on the right side and extending completely around to the left." On careful examination it was found that the skull cap could be felt to shift laterally, therefore there was apparently a complete fracture around the circumference of the calvarium.

This child was followed in the Return Clinic for two years without ever having any complaints referable to her accident.

The fact that in childhood the dura is not attached firmly to the inner surface of the bones of the vault, no doubt, explains the possibility of having extensive fractures of the vault without producing cerebral damage, while at the base where the dura is firmly attached, any fracture line lacerates the membrane.

There were twenty-seven patients with depressed fractures of the skull. Fourteen of these were compound fractures. In the thirteen patients with simple depressions there were few, if any, other symptoms due to the fractured skull or injury to the brain; in five the history noted that they had not been unconscious; one showed signs of an extension of the fracture line into the anterior fossa and in another apparently the middle fossa was also involved as there was some weakness of the side of the face. Two with depressions in the parietal region showed some weakness in the upper limb on the opposite side, but this soon disappeared. None of the patients with simple depressions were operated upon.

Of the fourteen cases with compound depressed fractures all were operated upon except one, a patient with a fracture in the frontal region, in which case the child was not admitted until twenty-four hours after the accident, and the wound was infected. Though the dura was open and brain tissue was presenting in the wound, the patient recovered, but now has a defect in his skull and has suffered with frequent headaches for three years. This case is the only one among the twenty-three with depressed fractures in which there is a complaint of a sequela.

The cerebral symptoms shown by the patients with compound depressed fractures were more commonly seen and were more severe than those with the simple depressed fractures. In five of these cases the dura had not been opened, two of these had no cerebral symptoms; the other three showed signs of compression. In the remaining nine cases the dura had been lacerated. Three of these showed no signs of brain injury; two had definite convulsions, and the remaining four patients were delirious and irritable, the result of definite laceration to the brain. There were four deaths, all in cases with signs of marked laceration of the brain substance. In three of the cases there are now bony defects in the skull due to the failure of the

operator to replace fragments removed at the time of operation; this causes discomfiture to the patient.

There was no case of extradural hemorrhage from the meningeal arteries in the entire series. Vance (*Archives of Surgery*, May, 1927, vol. xiv, pp. 1023) explains the infrequency of this condition in the young by the shallowness of the bony grooves for the meningeal vessels, and the slight attachment of the dura to the bones of the vault. There was, however, one patient, a boy of nine, who showed signs of a progressive increasing compression of the brain. He had a large tense hæmatoma of the scalp in the right parietal region. Incision into this hæmatoma evacuated blood under pressure. The hæmatoma communicated with the extradural space through a long fissured fracture. On further investigation the dura showed signs of having been compressed. The location of the origin of the hemorrhage could not be found. The patient recovered.

Seventy-four per cent. of the injuries to the skull were apparently fractures involving the base of the skull. Most of these cases fall into the moderately severe and grave groups. Of seventy-four cases of fracture of the base of the skull, where the X-ray demonstrated an actual fracture of that portion of the skull, in eight of the patients, there were no clinical signs of such fracture, and in three of these there were no signs of cerebral injury.

Seventy-four per cent. of the sequelæ reported from the Return Clinic were found in patients who had had a fracture of the base. This hardly needs an explanation.

There were thirty-eight deaths listed. This is not an accurate statement, as many cases were dead on arrival in the wards and these have not been included in this series. Seven cases died from meningitis, in all of these there was a fracture of the anterior fossa. Of the remaining thirty-one cases, twenty-eight died in the first forty-eight hours. All of these latter patients showed signs of severe laceration to the brain. In the three remaining cases who died over forty-eight hours and within five days after admission, death was apparently due to compression the result of œdema. One death was reported from the Return Clinic, of a boy who had a fracture of the middle fossa, and had been discharged apparently cured. He died in another hospital two years after the accident from an abscess of the brain.

Of 234 cases followed in the Return Clinic, 151 were of the fractured skull group and eighty-three of the intra-cranial injury group without a fracture of the skull. Forty-eight, or about 33.3 per cent. of the fracture of the skull group, had definite complaints of sequelæ, while only 6, or about 7 per cent. of the intra-cranial injury group, had such complaints. Thus about 23 per cent. of the followed cases of head injuries had some type of symptom following their accident. In most cases, these symptoms disappeared after a short period of time. Thus thirty-seven, 70 per cent., of these patients, in from one to two years, ceased to have such complaints. Of the

seventeen cases, with a continuous unsatisfactory Return Clinic record, seven showed no improvement over the period in which they were followed, six showed improvement, and in four, who were lost, the period during which they were followed was not long enough to form a definite opinion as to the final state of their health. So in eleven cases, or about 5 per cent. of those followed up, there was a possibility of permanent damage. None of the sequelæ, of the intra-cranial injury without a fracture of the skull group, continued longer than a year.

Only five of the cases with late complaints had fractures of the vault alone, but in all of these the fracture was extensive, and there was a definite injury to the brain. In twenty-nine of the cases with sequelæ in the fracture skull group, the fracture line passed through the middle fossa and frequently two or more of the fossæ appeared to be involved. The majority of the cases with sequelæ were classified as grave, from their original symptoms.

The symptoms of the fracture of the skull and of the brain injury were similar to those seen in the adult. Hæmatomas of the scalp appeared to be more commonly found overlying fractures of the vault. Bleeding from the orifices, nose and ear, were usually found in fractures of the anterior and middle fossæ, respectively. In only six cases out of sixty-six fractures classified as involving the middle fossa was there found cerebrospinal fluid discharging from the ear. But in approximately one-fourth of the fractures of the middle fossa, the diagnosis could only be made by X-ray examination as no typical clinical signs were present, though later submastoid ecchymosis occasionally developed. Subconjunctival hemorrhage was always observed in fractures of the orbital plate. Well-marked hæmatomas rather than sub-occipital ecchymosis appeared frequently in fractures of the posterior fossa.

Symptoms due to injury of cranial nerves were seen in twelve cases; in nine the facial was involved alone; in one the facial and abducens; in one the abducens and in one the facial and auditory nerves were affected. In all but three of these cases there was complete recovery, one of an abducens nerve paralysis, one of injury to the auditory nerve and one of facial nerve paralysis. The facial nerve paralyses usually disappeared rapidly, however, in two of the patients weakness of that side of the face continued for a year.

Infection of the middle ear followed fracture of the middle fossa in two cases. This resulted in an impairment of hearing until the condition was cured.

The symptoms referable to brain injury were similar to those seen in the adult. They varied from those caused by a simple concussion to those, the result of severe laceration of the brain. Symptoms of compression by sub-dural hemorrhage were fairly common, but as already stated, no case with the typical symptomatology of an extradural hemorrhage was observed.

In most of those cases that recovered, improvement in their condition was seen before the end of forty-eight hours. In fourteen cases there were symptoms of meningeal irritation, without further signs of infection. All of these patients recovered. In two cases, one with a weakness of both right

extremities, and the other with weakness of the left upper extremity, following apparent subdural hemorrhages, normal function of the parts were not regained until eighteen months in the first and two years in the latter case. There were, however, five other similar cases in which the condition cleared up before the children were discharged from the hospital.

The commonest symptom complained of by patients followed in the Return Clinic was headache. This was noted in twenty-five cases. In three patients it was accompanied by emotional changes as shown by the child's behavior. In four of the children the attacks of headache were accompanied by vomiting. Only one of these patients showed an objective symptom, a paralysis of the facial nerve. The description of the type of headache was quite constant, when noted. Coming on in attacks usually when the child was tired, and located in the frontal region. In all but one case the attacks gradually became less frequent and finally disappeared in periods varying from a few months to two years following the accident. The patient who continued to have headaches was the one in which there had been a depressed compound fracture which was not operated upon. The severity of the original injury did not appear to have any relation to the severity or duration of the headache. In five cases it followed simple concussion without a fracture; in fourteen the base of the skull was fractured resulting in more or less injury to brain substance. Four of these cases were classified as grave, four as moderate and six as mild. In the six remaining cases, the injury was a fracture of the vault, in only one of which was the cerebral damage grave.

Attacks of vertigo were reported by two of our patients. These patients showed no other signs following injury or later of semicircular canal disease, however, the fractures in both of these children involved the middle fossa. The attacks disappeared completely in eighteen months' time.

In nineteen cases the mother complained that the child's behavior had changed since the injury. In many of these, this fact was confirmed by the children's teachers. The severity of this change in behavior varied from mild emotional symptoms—" nervousness ", attacks of crying for no apparent cause or slight irritability—to a change in character, where the child became sullen, quarrelsome and incorrigible. In two of the cases, the patients, boys, had to finally be committed to public institutions. In the examination of the more severe types, the children were sullen and non-communicable and were frequently caught in mis-statements. In most of these cases there had been definite injury to brain tissue. In all but three the base of the skull had been fractured. In two cases the original injury had been classified as mild, nine as moderate and eight as grave. Ten children recovered entirely, six were much improved, but in three no change was noted. Two of the latter children had had extensive cerebral injury, and subtemporal decompressions had been performed upon them.

Improvement was rapid in the milder forms when there was coöperation

on the part of the parents. Care, isolation from emotional excitement and training quickly showed their effects on these children's behavior.

In the hospital care of these patients, in this series, operative procedures were seldom used except in cases in which there was a definite indication. In the earlier years, four cases of severe injury to the brain, accompanied by fractures of the base, were decompressed by subtemporal craniotomy. Two of these patients died and the two others showed later poor results.

SUMMARY

As in other injuries children stand severe cranial injuries better than adults.

The fact that the dura is not strongly attached to the bones of the vault and that the vessels of the dura lie in comparatively shallow grooves on the inner surface of the skull, prevents frequently laceration of the dura and brain in fractures of the vault.

Fractures of the vault may be often overlooked, as in many cases there are few, if any, symptoms, though hæmatomas of the scalp frequently overlie the fracture line.

The extent of a fracture line of the vault is of no prognostic value to the severity of the cerebral injury.

A simple depressed fracture of the skull is not in itself an indication for operative interference.

Compound depressed fractures are more serious than simple depressed fractures; not only because of the danger of infection that may follow, but because they more frequently produce lacerations to the dura and brain.

In operating for compound depressed fracture, bone fragments should be replaced, if possible, so as not to leave a deficiency in the skull.

Fractures of the base of the skull in children may be overlooked for the lack of clinical symptoms.

Injury to the brain is more commonly found accompanying fracture of the base than fracture of the vault. This is especially the case of fractures of the middle fossa.

Symptoms resulting from brain injury clear up rapidly after the first forty-eight hours, in the cases that recover; in those that die, death usually takes place in the first two days.

Symptoms of meningeal irritation without actual meningeal infection are often seen. Meningitis follows fractures of the anterior fossa more frequently than of any other part of the skull.

About 23 per cent. of children suffering from head injuries have some type of sequlæ, but few of them are permanent. Those having symptoms due to permanent injuries are less than 5 per cent.

As a rule it can be stated that sequelæ are present in direct relation to the severity of the damage produced by the injury.

Fractures of the vault have a lower morbidity than those of the base, especially those of the middle fossa.

The symptoms complained of in the sequelæ are more often of a subjective or emotional type than those of an objective type.

Headache is the commonest complaint and it usually clears up within a year after the accident.

Emotional instability is seen frequently. This varies anywheres from mild nervousness to a behaviorism which is a total change from the child's former character. These latter symptoms are found most frequently in those children who suffered from a serious injury to the brain.

Conservative treatment gives the best results in head injuries in children.

Operative procedures undertaken without definite indication are to be condemned.

THE USE OF VISOR FLAPS FROM THE CHEST IN PLASTIC OPERATIONS UPON THE NECK, CHIN AND LIP[1]

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Occasionally it is necessary to replace the skin upon the anterior surface of the neck and chin, usually in the correction of deformities due to burns, but sometimes for other reasons such as an injury or an extensive hæmangioma.

In these burns, although the face often is more or less involved, the chest may be spared, if protected by the clothing. This protection may even

Fig. 1.

Fig. 2.

be efficient when ignition of the outer investments is responsible for the trouble, as is so frequently the case.

As the burns heal, an unsightly condition develops. The scar becomes elevated into thick, red, longitudinal ridges, due to the stretching incidental to movements of the head and jaw, just as scars hypertrophy on the flexor surfaces of joints and in the axilla after operations for cancer of the breast. Although this deformity is bad enough, it is not the worst. In the course of time the chin is dragged down, perhaps almost to the sternum, the lower lip is everted and the teeth bared. (Fig. 1.)

Such unfortunates are indeed hideous spectacles—their heads tilted for-

[1] Read before the Western Surgical Association, December 9, 1927.

ward, their mouths wide open and drooling saliva, their lower lips turned inside-out, their teeth and gums showing, and their almost obliterated necks a mass of red scars and ridges. Even the cheeks and lower lids are distorted by the relentless tension.

It is not easy to correct this condition. It does no good to divide the contracted bands, because as healing takes place the deformity recurs. The first step must be the complete removal of the cicatrix down to the healthy tissues beneath, irrespective of the size of the wound produced. The lip can then be rolled upward into its natural position and the chin brought up to where it belongs. There should be no tension, even when the head is thrown back. (Fig. 2.)

FIG. 3.

This procedure, in bad cases, leaves a large denuded area extending, perhaps, from the lip to the sternum and more or less extensively from side to side. The problem is to cover this with normal skin so completely that contraction will not recur and the patient will present an acceptable appearance.

The transplantation of small, or even large, epithelial grafts is unsatisfactory, both as regards appearance and the prevention of contraction. Full-thickness grafts are better; but it is difficult to get sufficiently large ones to "take" in this position, although Blair has had considerable success with the method.

Pedunculated flaps, I believe, are preferable to grafts if they are adequately nourished, which often is not the case when the pedicle is single or "tubular" and the flap large. Under such circumstances it may perish or become so thickened and discolored as to be unsightly. These objections do not hold, however, when there are two pedicles, as in so-called visor-flaps.

Some twenty-five years ago I devised a method of operating which has given satisfactory results in four cases. It is only applicable, however, in instances where the skin of the chest is reasonably intact. It consists in the employment of a visor-flap from the upper thoracic region, with its pedicles attached to the sides of the neck in the vicinity of the ears. This, of course, is not a new principle; but as far as the neck and chest are concerned, so little attention has been called to it that I was until recently unaware that it previously had ever been used.[2]

[2] Perthes: Archiv. Klin. Chir., 1923, B. 127, s. 165—"Über Visierlappenplastik, etc."

FIG. 6.—Same as Figs. 4 and 5, some weeks after operation.

FIG. 5.—Same as Fig. 4, shortly after operation.

FIG. 4.—Hæmangioma involving neck, chin and lip.

Technic.—After removal of *all* the scar-tissue, so that the lip and chin come easily into their proper positions, even when the head is thrown back (Fig. 2), a flap of the proper size to cover the raw area is loosened from the chest, its upper border being coincident with the lower border of the raw surface to be covered. (Figs. 1 and 2.) The incision outlining the lower margins of the flap should curve upward on each side of the neck toward the ears, far enough from the anterior denuded area to provide

FIG. 7.—Same as in previous figures, several months after operation.

FIG. 8.—Result of visor-flap operation after about fifteen years; the original lesion being a red corrugated scar which had dragged the chin and lip down almost to the sternum, obliterating the contour of the neck.

pedicles an inch or more in width, according to the requirements of the case. (Fig. 2.)

The large flap with its pedicles is then loosened and slid upward so as to cover the anterior part of the neck, and if necessary the chin and lower lip, with a single piece of normal skin. (Fig. 3.) It will be found that the flap and its pedicles usually fit so accurately in their new position that no redundancy has to be adjusted or removed later on.

In order to facilitate closure of the chest wound and also to provide ample skin for the median line of the neck, thus guarding against possible subsequent tension, it is well to curve the chest incision downward into more or less of a tongue. (Figs. 1 and 2.)

The raw surfaces resulting from the lifting of the flap and its pedicles must now be covered, which generally can be accomplished by extensively undermining the adjacent skin—downward on the chest, outward toward the shoulders and axillæ and upward around the sides of the neck. In stretching

the loosened skin into position, stay-sutures passing through large buttons or lead plates are of service.

It will be seen in closing the V-shaped wound over the sternum that the flap is pushed further upward and supported in that position, which is an important feature of the operation. (Fig. 5.) If the wound upon the chest cannot be completely united, it may be skin-grafted; or allowed to cicatrize, removing the scar later by the multiple-stage method by Sistrunk.[3]

In suitable cases it is surprising what a comparatively satisfactory chin, lip and neck may be obtained by a single visor-flap from the chest, the skin being smooth, white, supple and free from scars, blemishes, or tendency toward unsightly thickening such as is seen in insufficiently nourished flaps with a single pedicle. (Figs. 4, 5, 6, 7, and 8.) The only scars which cannot readily be concealed by the clothing are linear ones and mostly horizontal, hence exhibiting little tendency to hypertrophy. In fact, individuals who previously were mere caricatures of humanity, abhorrent to themselves and to others, may be transformed into tolerable, if not handsome, members of society.

H. D. Gillies[4] recommends the use of visor-flaps from the chest with "tubularized" pedicles. Although this may be required at times, especially where the flap must be transferred from a distance, in my own cases it was unnecessary, thus avoiding much post-operative manipulation and producing, I believe, a better cosmetic result.

[3] Annals of Surgery, vol. i, 1927, p. 185.

[4] Plastic Surgery of the Face. Oxford Press, 1920, p. 356.

MALIGNANT DISEASE OF THE THYROID GLAND: A CLINICAL CONSIDERATION *

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from the section on surgery of the mayo clinic

The prevailing belief is that malignant disease of the thyroid gland is of extreme rarity, and incurable. Many are of the opinion that no treatment is more than palliative. Surgical measures are considered of little avail. and may be even discouraged whenever malignant disease can be diagnosed clinically. Although "cures" following the surgical removal of malignant tumors of the thyroid have been recorded, it has been intimated that in these instances the pathologic diagnosis of malignancy was of necessity erroneous, if the criteria of the malignancy of a tumor of the thyroid are tumor invasion, metastasis and death of the patient. However, the impression gathered in an active thyroid practice has led me to believe that this view is extreme and unnecessarily pessimistic. In order to determine the facts, a study has been undertaken of all the cases of malignant disease of the thyroid in the Mayo Clinic from 1907 to 1926 inclusive. In collaboration with Doctors Broders and Bueermann, I studied the gross and histologic pathology of each specimen removed and classified and graded the neoplasm according to degree of malignancy (Broders); we reviewed and tabulated the histories and made an attempt to ascertain the present condition of each patient. The material for this study includes 276 operative cases and 181 non-operative cases.† The operative list is comprised of those cases in which the surgical specimen was diagnosed by the pathologist, usually at the time of operation; in a few instances, however, the malignant changes were not recognized by the pathologist during the routine examination and were only discovered later when the history of the patient's condition warranted reëxamination of the specimen. The pathologic diagnosis of malignant disease of the thyroid is admittedly difficult, even for pathologists long-experienced in lesions of the thyroid, but the errors are chiefly those of omission, that is, failure to recognize malignant disease when present; to-day the trained pathologist seldom makes the mistake of calling a benign tumor malignant. While this study is not yet finished, this paper is based on the clinical analysis of the data revealed. A complete report will be published later.

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* Read before the Pacific Northwest Medical Association, June, 1927.

† The non-operative cases include all cases of inoperable cancer of the thyroid observed in the Mayo Clinic in the years 1910 to 1926 inclusive. Cases observed in the years 1907, 1908 and 1909 have not been included because the cross-indexes of non-operative cases for these years are not available.

Pathology.—During the years 1907 to 1926, inclusive, 276 patients with malignant tumors of the thyroid were operated on at the Mayo Clinic. The lesions have been classified as shown in Table I.

Etiology.—Wilson has computed the general incidence of malignant tumors of the thyroid as shown by necropsy records: For Europe 1:224, and for the United States 1:928. The highest incidence was found in goitrous districts; thus Müller and Speese reported the incidence in Berne, Switzerland, 1:93. Data are not available to determine the relative frequency of malignant and benign tumors of the thyroid, as extensive surveys of the incidence of both conditions in large populous communities would be necessary. As Balfour pointed out, the proportion computed from clinic and hospital registrations does not give an accurate ratio, since many of the patients with

TABLE I.

Malignancy of the Thyroid Gland. Operative Cases, 1907 to 1926 Inclusive.

	Cases	Per cent.
Sarcoma	3	1.0
Diffuse carcinoma		25.0
Grade 1	0	
Grade 2	14	
Grade 3	16	
Grade 4	39	
Malignant adenoma		39.0
Grade 1	29	
Grade 2	60	
Grade 3	16	
Grade 4	3	
Papillary adenocarcinoma		31.0
Grade 1	54	
Grade 2	31	
Unclassified*	11	4.0
Total	276	

* Tissue not available for reëxamination.

the simple nodular goitre never seek medical advice, while all patients with carcinoma of the thyroid eventually come to the physician. In the Mayo Clinic from 1910 to 1926, inclusive, the ratio of malignant tumors of the thyroid to all simple goitres (adenomatous and colloid) was 438:16,110 or 1:36.7 (2.7 per cent.). During the same period the ratio to all goitres (including exophthalmic) was 438:26,310, or 1:60 (1.66 per cent.).

Eighty-one (29 per cent.) of the 276 patients operated on were males, and the remainder, 195 (71 per cent.), were females. In the group of 181, seventy-three (40 per cent.) were males, and 108 (60 per cent.) were females. Malignant disease of the thyroid is more frequent in the female in the proportion of 2:1. A comparison of the sex incidence of all tumors of the thyroid which is 3.5 females to one male, shows the incidence of malignant tumors to be relatively higher in the male.

The ages (in decades) of the 276 patients operated on were as follows: Two were nine years; six were between ten and nineteen; twenty-four were between twenty and twenty-nine; fifty were between thirty and thirty-nine; seventy-five were between forty and forty-nine; sixty-five were between fifty and fifty-nine; forty-six were between sixty and sixty-nine, and six were between seventy and seventy-nine. The youngest patient was a girl aged seven with a carcinoma in a fetal adenoma; the oldest was seventy-seven. These ages correspond to the age incidence of carcinoma in general; in 69 per cent. the patients were in the fourth, fifth and sixth decades.

In the discussion of the direct predisposing factors of malignant disease of the thyroid gland practically all writers have pointed out the great frequency with which carcinoma has been preceded by the presence of a goitre. It is difficult to obtain accurate information on this point from a study of the history alone. Repeatedly the general examination of patients with hyperthyroidism of long standing reveals the presence of a partly concealed adenoma unsuspected by them. If carcinoma of the thyroid developed in this manner, and unless the malignant growth was definitely encapsulated in an adenoma, it might be erroneously suspected that the carcinoma originated primarily in the thyroid gland. On the other hand, a malignant tumor of the thyroid may develop primarily in the gland and practically remain stationary for a year or two before rapid growth begins. In such instances the origin of the malignant neoplasm would be mistakenly ascribed to an adenoma.

In the series of 276 patients operated on, 224 gave a definite history of a preëxisting goitre of two years' duration or longer. The average duration of the goitre in this group was thirteen and seventy-seven hundredths years. Examination of specimens removed at operation on the remaining fifty-two patients, who had noted the presence of the tumor for less than two years, showed unmistakable evidence of the carcinoma arising in fetal adenoma in fifteen instances. Thus of 276 patients with malignant disease of the thyroid, 239 (87 per cent.) presented unquestionable evidence (conservatively estimated) that the malignant neoplasm originated in a preëxisting goitre. In only one instance in this series did the malignant growth develop in the hypertrophic thyroid gland of exophthalmic goitre.

Symptoms on which the diagnosis can be made definitely are usually not present until the malignant tumor has invaded the capsule of the gland and has become adherent to the surrounding structures. At this time a hard, irregular, nodular tumor, often unilateral, fixed in its bed, with or without cervical involvement frequently associated with hoarseness and paralysis of a vocal cord, a sense of pressure in the neck, dyspnœa and loss of weight is presented; then and not till then is the diagnosis apparent. Unfortunately, now that the diagnosis is obvious, the disease may have advanced beyond the reach of the surgeon.

Of the 438 patients with malignant lesions of the thyroid (operative and non-operative) in the Mayo Clinic in the years 1910 to 1926, inclusive, the

clinical diagnosis of malignancy was made in 237 (54 per cent.). In thirty-nine a tentative diagnosis was made; thus the combined absolute and tentative diagnosis was made in 276 (61 per cent.). Of the 276 patients with malignant tumor diagnosed clinically, only ninety-eight (34 per cent.) were operated on; in the remaining 66 per cent. the tumor was clinically inoperable and surgical procedures were not undertaken. The group of 276 patients presented prominent symptoms as follows: Hoarseness, forty-five (16 per cent.); dyspnœa, 125 (45 per cent.); pressure in the neck, 125 (45 per cent.); paralysis of one or more vocal cords, forty-five (16 per cent.); involvement of the right cord, twenty-three, and of the left, twenty-two; recent loss of ten pounds or more in weight, ninety-two (33 per cent.); and rapid growth of tumor of two years' duration or less, 134 (48 per cent.).

Does malignant thyroid tissue function? Since benign thyroid tissue both normal and abnormal has the peculiar ability of fixing and retaining iodine, Marine and Johnson and later Eisen suggested that the quantitative estimation of iodine in the malignant tumor and its metastatic nodules (as well as in the normal gland) provides a measurable index of its function. The results of their studies showed that the malignant tissue is unable to retain iodine. Since 1918, basal metabolic estimations have been made on eighty-seven of the patients with malignant tumor of the thyroid. Of this number, fifty-three (61 per cent.) recorded rates within the normal limits; thirty-one (26 per cent.) recorded rates elevated from +16 to +81, and three (3 per cent.) recorded subnormal rates of −18, −20 and −30. Thus malignant disease of the thyroid gland does not produce any constant effect on the basal metabolism, and because of the presence of co-existing benign tumors of the thyroid in such a high percentage of cases of carcinoma of the thyroid, it is more logical to conclude that these variations in basal metabolism are influenced more by the benign than by the malignant tumors. It may be concluded, therefore, that the basal metabolic rate is of no aid in the differential diagnosis of malignancy.

In the absence of the characteristic fixed hardness, the presence of any one of the foregoing symptoms is not sufficient to make a diagnosis of malignant disease, but one should always suspect it in any case of goitre in which there is a history of recent rapid growth, and particularly if this is associated with a fixed vocal cord and hoarseness. The paralysis of one vocal cord is not infrequently noted in the laryngeal examination, but unless there is also definite hoarseness, it is of no special significance. But the presence of the combination of hoarseness and paralysis of a vocal cord, in the absence of previous operation on the neck and in the absence of syphilis and a cardiovascular lesion, is almost sufficient evidence of malignancy.

In 276 cases in which operation was performed, a pre-operative diagnosis of malignant disease was made in fifty-six (20 per cent.) and it was suspected in forty-two (15 per cent.), a total of ninety-eight (35 per cent.). In other words, in 65 per cent. of these cases the diagnosis was not suspected

by the clinician. The surgeon fared somewhat better. A review of the operative findings shows that the surgeon was able to diagnose, or at least suspect, malignant disease in 191 cases (69 per cent.) and was entirely ignorant of its presence in eighty-five cases (31 per cent.). I believe, however, that these figures give too much credit to the surgeon's diagnostic ability, for unquestionably in many instances a supposedly benign goitre is removed, and before the surgeon's observations are dictated, the pathologist has made his report of malignancy; the surgeon then incorporates this data in his own record, unwittingly taking credit from the pathologist.

In the differential diagnosis the lesions most likely to be mistaken for malignant tumor of the thyroid are, diffuse subacute thyroiditis (Reidel's struma), hemorrhagic adenoma, large cystic or calcareous adenoma, and Hodgkin's disease. In any of these, surgical exploration may be necessary to establish the diagnosis. The really important practical point in the differential diagnosis is that clinically it is impossible in a large percentage of cases to know definitely whether a nodular tumor is malignant or benign.

Metastasis.—Distant dissemination from untreated carcinoma of the thyroid through both the lymph and blood is common, and is manifested by single or multiple nodules. In many cases these occur apparently early in the course of the disease. In the entire series of 438 cases definite evidence of metastasis was noted on admission to the Clinic in 108 (24.6 per cent.); 105 of these were non-operative and three (cervical involvement) were operative. The most frequent sites of metastasis in the 105 cases were as follows: Regional nodes, seventy-three (69.5 per cent.); lungs, twenty-five (24 per cent.); chest and mediastinum, seventeen (16 per cent.); and bones six. In the others the site was in various parts of the body, such as axilla, liver, trachea, brain, œsophagus, kidney and scalp.

Treatment.—In a consideration of the treatment of malignant disease of the thyroid gland the subject must be discussed from three angles: that of the early case, of the late case, and of the benign adenoma (as a precursor of carcinoma). The indications for operation in the presence of known metastasis are exceedingly limited; for example, for relief of tracheal obstruction, and in some instances in which the cervical nodes are involved by milder papillary adenocarcinoma, provided the primary and secondary tumors can be removed without undue risk. Therefore, it can be readily appreciated that the skiagrams of the lungs and bones are necessary in all suspected cases of malignant tumor of the thyroid before surgical procedure is advised.

For convenience of discussion the early case of malignant tumor of the thyroid may be defined as one without extensive fixation to surrounding structures by invasion and without metastasis. The pre-operative diagnosis may or may not have been made, and the operation may have been completed without the surgeon suspecting the nature of the growth. In other words, the carcinoma is confined within the capsule. My convictions are that the removal of all the adenomatous tissue without rupture is ample, and that

an endeavor at complete extirpation of all the thyroid tissue is unnecessary. If the carcinoma is not definitely encapsulated, total removal of the affected lobe is indicated. In all cases a large rubber drainage tube is left in the cavity so that subsequently (twelve to forty-eight hours) radium may be inserted directly into the wound. Later, during convalescence, further topographical applications of radium and Röntgen-ray treatment are indicated. Additional courses of irradiation are advised, depending on the type and degree of malignancy.

The late case is one in which there are varying degrees of fixation of the tumor; therefore operability, so far as the excision of the local growth is concerned, is questionable. Metastasis may or may not be present. If at operation the tumor is found to be resectable, complete extirpation of the lobe is indicated with supplemental courses of external irradiation and Röntgen-ray treatment. If the local growth cannot be removed at operation, radium needles (ten to twenty) may be buried about 1 cm. apart, in the tumor by means of steel-alloy points containing 10 mg. of radium sulphate each (Bowing). Silk threads are attached to the needles so that the operative wound may be closed and the needles removed aseptically within twelve to twenty-four hours. Further irradiation is given during the convalescent period and subsequent courses of treatments every two or three months. In this manner the local tumor is often made to disappear or is kept under control, and not infrequently deep metastatic nodules are diminished remarkably. Probably in no other malignant disease are radium and the Röntgen-ray so valuable as in the treatment of malignant tumors of the thyroid. Cures by irradiation in such cases can hardly be expected, but reducing the size of the tumor, and extending the patient's life by from two to four years is not uncommon. Since 1918, operation in conjunction with irradiation has been employed in the Mayo Clinic, as outlined here, in most of the cases of carcinoma of the thyroid gland coming to operation.

In view of the fact that carcinoma of the thyroid develops in from 80 to 90 per cent. of cases in a preëxisting benign adenoma, and in view of the known frequency of carcinoma of the thyroid, should all adenomatous goitres be considered precursors of carcinoma, and their removal urged? That the retention of adenomatous goitre entails a certain risk of carcinoma cannot be denied. The extent of the risk cannot be estimated accurately in the light of our present knowledge of the actual and relative incidence of benign and malignant tumors of the thyroid. I believe, however, that this danger is sufficient to be taken into account in formulating an opinion as to the advisability of the removal of a simple nodular goitre, and in view of the exceedingly low operative risk and morbidity, and the very small incidence of recurrence after operation in patients aged thirty years or more, I believe that we are warranted in stating the facts to the patient and advising operation. When this danger is considered in conjunction with the other potentialities of a retained adenoma, that is, development of hyperthyroidism and extension of

the growth, I believe that with proper hospital facilities and in the absence of specific contra-indications, we should urge the removal of all adenomatous goitres.

Results.—Statistics on the results from operation for carcinoma, to be of any value, must be based on the condition of the patient at least three years after operation. In analyzing the results in this series, the cases in the last three years (1924, 1925 and 1926) have been omitted. Of the 205 patients in the series, sixty-six (32 per cent.) are known to have been alive in November, 1926, a period of from three to eighteen years (Table II).

The end results are influenced by the type and degree of malignancy. Of

TABLE II

Patients Operated on for Carcinoma of the Thyroid, 1907 to 1923 Inclusive

	Patients	Living*	Per cent.
Sarcoma	1		
Diffuse carcinoma			21.0
Grade 2	7	1	14.0
Grade 3	12	3	25.0
Grade 4	32		
Malignant adenoma			38.7
Grade 1	14	9	64.0
Grade 2	49	18	36.0
Grade 3	15	3	20.0
Grade 4	1	1	100.0
Papillary adenocarcinoma			48.0
Grade 1	42	20	47.0
Grade 2	22	11	50.0
Unclassified	9		
Total	204	66	32.0

* Recurrence in a few cases.

the nineteen patients with diffuse carcinoma, four (21 per cent.) are living. Of the eighty patients with carcinoma in fetal adenoma, thirty-one (38.7 per cent.) are living. Of the sixty-four patients with papillary adenocarcinoma, thirty-one (48 per cent.) are living. During the period from 1907 to 1921, inclusive, it is found that of the 167 patients operated on seventy-one (42 per cent.) lived for five years or longer, although it is known that some of these "cured" patients died subsequently, a few from recurrence of the malignant disease.

Because of the oft-repeated statement that surgical procedures are of no value in cases of carcinoma of the thyroid in which the diagnosis can be made pre-operatively, it is of considerable interest to check the actual results. In the seventy-six cases of carcinoma of the thyroid gland (1907 to 1923) in which carcinoma was diagnosed or suspected pre-operatively, twenty-five

(32.8 per cent.) of the patients lived for three years or longer; eight are still alive, after a period of from three to eight years; in one case it is known to have recurred. In two cases, resection of the malignant tumor and excision of cervical nodes involved by metastasis were carried out. Both patients are well, four and five years after operation.

SUMMARY

The clinical study of 457 cases of malignant disease of the thyroid (276 operative and 181 non-operative) may be summarized as follows: The frequency of carcinoma of the thyroid as compared with benign nodular tumors is 1:36.7 (2.7 per cent.) as compared with all benign enlargements, 1:60 (1.66 per cent.). The age incidence corresponds to that in cases of carcinoma in general; 69 per cent. of the operative cases were in the fourth, fifth, and sixth decades of life. The malignant lesion predominates in the female in the ratio of 2:1. In 87 per cent. of all the cases there was definite evidence of a preëxisting benign goitre. Pathologically, the malignant tumors were classified as sarcoma 1 per cent., diffuse carcinoma 25 per cent., carcinoma in fetal adenoma 38 per cent., and papillary adenocarcinoma 30 per cent. Even in the absence of the characteristically hard, irregular nodular tumor fixed to the neighboring tissues, malignancy should be suspected in all tumors of the thyroid in which there has been recent rapid growth, with or without associated hoarseness and paralysis of a vocal cord. The clinician suspected the malignant nature of the tumor in only 35 per cent. of the operative cases and the surgeon suspected it in 69 per cent. Metastasis occurs through the lymph and blood. It occurs frequently, and often early in the course of the disease. The most frequent sites of secondary involvement are: regional nodes 69 per cent., lungs 24 per cent., chest and mediastinum 16 per cent., bones 6 per cent. Operation supplemented by irradiation is the choice of treatment. The adenoma must be looked on as a precursor of malignancy, although the danger entailed by the retention of an adenoma cannot be computed; it is not over 2.7 per cent.

The results of the surgical treatment of carcinoma of the thyroid are more encouraging than is popularly believed: of the 204 patients operated on during the years 1907 to 1923 inclusive, sixty-six (32 per cent.) are living after a lapse of from three to eighteen years. These results are influenced for the most part by the type of the growth and the grade of the malignancy. Of those with sarcoma, none is alive; of those with diffuse carcinoma, 21 per cent. are alive, with carcinoma in fetal adenoma, 38 per cent., and with papillary adenocarcinoma, 48 per cent. In the cases in which malignant disease was diagnosed before operation, 32 per cent. of the patients are living three years or longer.

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TONSILLECTOMY WITH BLOODLESS TECHNIC

By W. Wallace Walker, M.D.

of Baltimore, Md.

There are as many methods of removing tonsils as there are operators. All have varied technic and good reason for such procedure. However, their end results differ only in the number of complications. It seems that lung abscess and hemorrhage are the captains of complications. The most logical method in preventing the complications is to eliminate the cause, which is bleeding.

Before describing the operation, the instruments used in this procedure are listed first, viz: 1. Endothermy machine. 2. Mouth gag. 3. Tyding's snare, or any snare that can be insulated. 4. Murphy's double-edged dissector. 5. Insulated clamp. 6. Tenaculum.

1. *Endothermy Machine.*—Three types have been tried and all give satisfaction. The inactive electrode used is made of meshed copper.

2. *Mouth Gag.*—I am more familiar with the Davis type of gag. Any type is suitable, depending on the preference of the operator.

3. *Tyding's Snare in Diagram.*—Any snare can be used that is easily insulated. The insulation should extend at least one-eighth of an inch beyond cylinder where the wire protrudes. All parts coming in contact with patient's mouth must be insulated.

4. Double-edged dissector or knife depending on preference of the operator.

5. *Insulated Clamp.*—The entire clamp is insulated excepting the tip, so that when the current is applied, only that part of the tissue grasped with the end of clamp is coagulated.

6. *Tenaculum.*—Any heavy instrument with at least four teeth allowing a firm grasp can be secured, permitting strong traction.

The entire tonsil is to be removed with its capsule intact. The tonsil is freed from its pillars by dissection and finally severed from its connection to its bed with the electrical snare.

The operation should be preceded by an examination of heart, lungs, urine and blood-clotting time. Atropine 1/150 gr. to all patients over ten years of age. It is well to see that the teeth are in good condition and clean.

Anæsthesia.—Ether not to exceed second stage. Adult patients are started with gas and oxygen and switched to ether. All patients should be put to sleep in a room especially prepared for such procedure. Before applying current to snare, the patient should have fifteen expirations.

Position.—Recumbent on a narrow table. If a metal table, have a thick pad between patient and table, preferably have the table insulated with rubber mats or tires. For this reason the average operating room carriage serves the purpose well.

Landmarks.—The contour of the tonsil and the anterior and posterior pillars and the fauces.

Electrical Technic.—The mesh electrode, 4 x 10 inches, is dipped in thick green soap. The smooth side wrapped snugly about the arm with an elastic bandage. (Fig. 1.) The inactive wire is attached to the mesh electrode by means of a metal clasp. Always attach clip to external surface of arm electrode, not allowing it to come in contact with patient's arm (see Fig. 1), preventing possible burns.

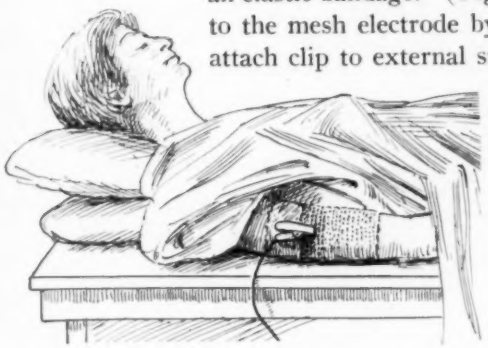

FIG. 1.—Inactive electrode applied to arm. The clasp attachment insulated from patient's arm by gauze bandage.

The current used in this operation is of the bipolar d'Arsonval damped type, produced by an apparatus consisting of a transformer, spark gap and Oudin coil. The active electrode is the tonsil snare and the inactive one a brass mesh strapped to the arm. The current used has two qualities, first cutting, second coagulation. The former is obtained by closely approximating the points of the spark gap. Coagulation is obtained by adjusting the transformer to the desired capacity. When beginning to use a new machine, one should test the various settings of the transformer and spark gap to determine the depths of penetration of the different strengths of currents. The ideal current is a cutting current which will coagulate the tissues to a depth of about one-half to three-quarters of a millimetre on each side of the snare. This leaves a white film over the tonsil fossa, preventing bleeding. The snare should be contracted slowly but steadily in order to insure an evenly distributed effect, but rapidly enough to prevent too deep coagulation at any point, giving rise to secondary hemorrhage. *Operation.*—The tonsil is seized with a tenaculum and drawn toward the median line. The dissector for denuding the mucous membrane is inserted to the depth of one-fourth of an inch between the anterior pillar and tonsil, cutting at the junction of the anterior pillar and the tonsillaris, where the tonsil is not adherent and is generally readily demonstrated with the tongue well depressed. (Fig. 2.) The dissection is carried upward along the anterior aspect of the tonsil and then over the marginosuperiotonsillaris to the posterior pillar. By passing above the marginosuperiotonsillaris, the part of the tonsil in the supratonsillar fossæ is freed. Drawing the tenacu-

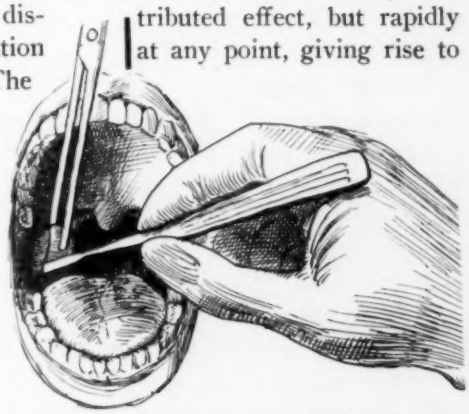

FIG. 2.—Separating the anterior pillar from tonsil. Same procedure on posterior surface.

lum forward exposes the posterior aspect of the tonsil. The knife is now turned to sweep backward and downward, freeing the posterior pillar from the tonsil, always cutting toward the midline and away from the tonsil. The wire of the snare is slipped over the handle of the tenaculum. Strong traction is made on the tenaculum, dislodging the tonsil as much as possible from its bed toward the midline. The snare wire is bent to a right angle, and slipped beneath the pillars, the curve of the wire over the top pole and the base of the snare below the lingual tonsil, gradually depressing the handle of the snare, tightening the wire about the base of the tonsil. (Fig. 3.) The current is turned on by means of a foot switch, the handle of the snare being gradually depressed, letting the current cut through the tonsil pedicle. The tonsil comes away, leaving a clean dry field, the fossæ being covered by a gray, thin film of coagulation. Occasionally there will be a small bleeding point, especially in cutting through scar tissue. This bleeding point is clamped with the insulated clamp touched with the same current used on the snare. The vessel is coagulated, immediately stopping the bleeding. If there should be a small ooze, the needle is applied directly to the bleeding point, the spark causing sufficient charring of the blood to prevent further bleeding. These difficulties are seldom and much less frequent after one becomes accustomed to the machine and the type of tonsil which is being removed.

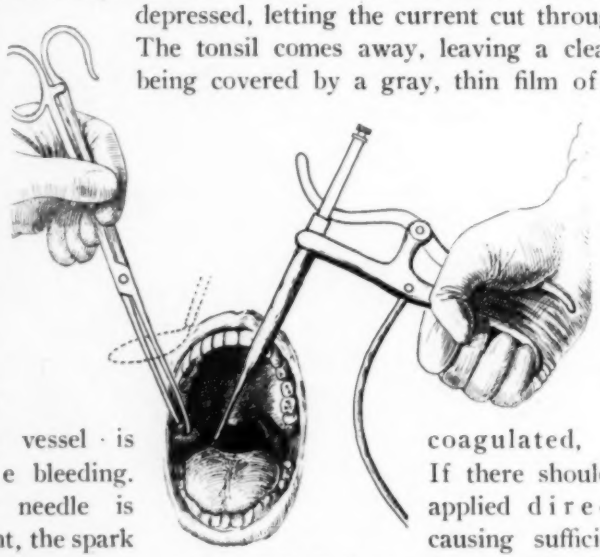

FIG. 3.—Application of snare. All parts insulated coming in contact with patient's mouth.

Hemorrhage.—Primary and secondary hemorrhage has been one of the most frequent and serious complications of tonsillectomy. Doctor Gerald Hutchinson Cox (*N. Y. State Medical Journal*, April, 1925) collected and reported 261 severe tonsillar hemorrhages; one hundred and twenty-five fatal. He concludes that the most frequent cause of tonsillar hemorrhages are traumatism at operation and neglect to secure a dry field by ligating all bleeding points. In using the electrical snare, there is no primary hemorrhage and very little trauma, avoiding the big dangers of the cutting operation. In only six cases out of three hundred has there been any post-operative bleeding. Four of these cases reported two weeks after operation for examination, gave a history of expectorating a small amount of blood-stained sputum after eating solid food. Two of the six cases reported to the hospital oozing a small amount of blood from the granulating area in the region of the lingual tonsils. One case reported eleven days and one eight days following opera-

tion. Neither of the cases had much bleeding and were easily controlled with a stypec. In all of the post-tonsillar oozing, the lingual tonsils had been removed by coagulation with the needle after the faucial tonsil had been removed with the snare.

Lung abscess following tonsillectomy cannot be dismissed without much consideration when reports from the Mayo Clinic, 1924, that 31 per cent. of lung abscess followed tonsillectomies. Chevalier Jackson in the *Atlantic Medical Journal,* February 26, 1927, writing on the subject of post-tonsillectomy pulmonary abscess, says Myerson found blood bronchoscopically in 76 out of 100 cases of tonsillectomies. As the source of blood was from the tonsillar field of operation, the inference is justified that the blood carried infected material from the tonsil. If we have no blood at the time of operation, we completely eliminate this possibility.

Another feature of this type of tonsillectomy is the small amount of post-operative pain. In a number of adult cases, one tonsil was removed by blunt dissection and the other with the electrical snare. Invariably, the patient complains of more pain on the side removed by blunt dissection. It was then thought that the trauma to the tissue played a part in post-operative pain, so a number were removed with the snare without any current. Without fail, the patients complained of more pain on the side where no current was used. It is hard to say just why a coagulated base gives less pain than a cut one, but the theory that the nerve endings have been coagulated rather than left exposed is undoubtedly a good one. Be that as it may, the fact remains that they do have less post-operative discomfort with this method.

Over 90 per cent. of the 300 cases reported for examination, one week after operation, at that time, the fossæ was covered with a soft yellowish membrane. Swelling and œdema are practically negative. Two weeks after operation, only 54 per cent. reported for examination. At that time, the fossæ was clean and there was no discomfort. Three weeks after operation, only 29 per cent. reported for examination and at that time the throat was healed.

Of 300 cases there has not been a single complication except six bleeding cases mentioned previously.

To determine the depth of penetration of the current, numerous sections were made from picked and routine cases. The average is about 4 microns.

PRIMARY SARCOMA OF THE CLAVICLE

By Lewis Barclay Bell, M.D.
of Chicago, Ill.

Primary sarcoma of the clavicle is a rare condition and when it does occur, it is as a rule rapidly fatal. The case reported herein is one in which the patient is living three years after the removal of the sarcoma. Careful perusal of the literature reveals only seven cases in which the patient lived three years or longer.

Case Report.—Miss E. S.,* seventeen years of age, noticed a hard, marble-sized lump on her right clavicle two months before presenting herself for examination. This lump was tender to pressure and painful whenever the arm was moved quickly. The patient complained of slight dizziness and weakness. She had lost about ten pounds in weight. The mass had grown rapidly larger and became softer and more tender, so that on May 19, 1924, it measured 7 cm. in length, 3 cm. in width, and 3 cm. about the clavicle. It was a smooth lemon-shaped enlargement involving the middle third of the right clavicle. The overlying skin was of normal color and was freely movable over the underlying structures. The mass seemed to be an integral part of the clavicle. It was soft and fluctuating in the central portion. Aspiration secured about 3 c.c. of dark red blood, indicating a possible angiosarcoma.

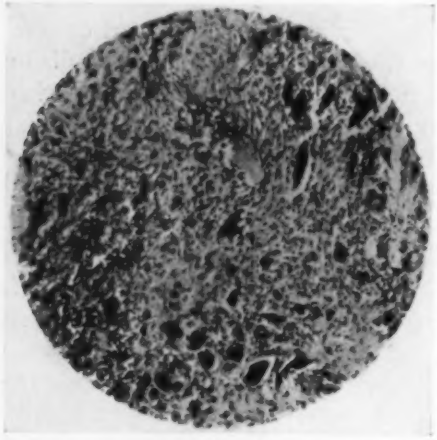

Fig. 1.—Section from tumor showing spindle cells and osteoclastic giant cells. Small spicules of bone are present in this section (x 140).

General examination revealed nothing to suggest syphilis or tuberculosis. There was no fever; the leucocyte count was 9000, the red count was 4,040,000, and the urine showed neither albumen nor sugar. The Wassermann test was negative. Family history recorded no tuberculosis or malignancy. Preceding the appearance of the growth, however, there was a definite history of trauma as a relative had frequently struck her violently about the head and shoulders in his fits of ill-temper.

Röntgenological examination showed the tumor mass, an area of partial destruction of the clavicle and apparently a distinct reflection of the periosteum up over the tumor mass proper. These findings pointed strongly toward a diagnosis of bone tumor. There was no bony capsule that would have suggested osteitis fibrosa cystica.

On May 19, 1924, under ether anæsthesia, I excised the entire clavicle and tumor in the following manner: An incision was made the full length of the clavicle following the midline of the bone over the tumor. The skin was dissected back, the muscle insertions were removed, and the periosteum was freed all around the normal portion of the clavicle. Then with a rib-cutting gullitome the bone was divided 3 cm. proximal to the new growth. The distal portion with the tumor was elevated and disarticulated, and

* The case of Miss Evelyn Smith sent for registration has been given No. 823 of the Registry of Bone Sarcoma series and classified as an Osteogenic Sarcoma.

The last note we have as to patient's condition is that on April 12, 1927, she was working every day and feeling fine. Broman C. Crowell, Registrar, Committee on Bone Sarcoma, Depart. Clin. Research, Amer. Coll. Surgeons, Dec. 13, 1927.

the other segment was likewise removed. The remaining portion of the periosteum was carefully dissected off, leaving only that part lying over the great vessels near the sternum. There was no bleeding. A small gauze drain was inserted. The skin was closed with interrupted silkworm-gut sutures. At the end of twenty-four hours the drain was removed. The large dressings were saturated with serum but the wound healed by first intention. Recovery was uneventful and the patient left the hospital on the fourth day after the operation.

The specimen was examined by Dr. H. R. Fishback, who reported as follows:

Gross Description.—The specimen consists of a clavicle 15 cm. in length and of normal contour except for an enlargement of the shaft beginning just outside the sterno-clavicular articulation. This mass projects downward and posteriorly, filling in the arc of the first curve of the clavicle. The mass is spheroidal, extending along the bone 5.5 cm. and being 3 cm. in diameter at its thickest portion. The upper and anterior portion of the wall is composed of the thinned shaft of the bone which is unchanged externally. The wall of the projecting mass is about 1 mm. in thickness and is fibrous in character. Many small bony deposits are found in this.

The enclosed tumor mass is friable and pinkish-red in color. Some areas are soft and almost jelly-like, while others are firm and show considerable connective-tissue stroma. There are areas of hemorrhage into the structure. The tumor can be pulled from the bone rather easily and exhibits small projections into the cancellous spaces of the bone. The bone surface shows absorption. No gross extension through the capsule is made out, and there is no extension into the bone shaft beyond the area of widening.

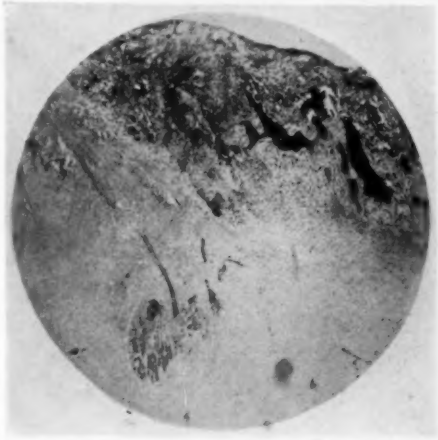

FIG. 2.—Section showing margin of tumor with two small hemorrhagic areas and an underlying degenerative process in which are spicules of bone (X 27).

Paraffin sections of the tumor were made and stained with hæmatoxylin and eosin. Some sections which included portions of the bone shaft were decalcified.

Microscopic.—The tumor tissue is generally of rather loosely placed cells of predominant spindle form, with many irregularly set giant cells and much blood, both diffused through the tissue and enclosed in blood channels. No bone formation is seen in the tumor proper.

The spindle cells vary from young cells of varying form, with hyperchromatic nuclei and an occasional mitotic figure, to older cells of thin spindle form associated often with mature connective-tissue fibrils. The younger cells are found often in rather large groups with a rich blood supply. In these groups also are found most of the giant cells. They are variable in size up to 25 micra and show an opaque cytoplasm with many separate small oval nuclei, which tend to central location in the cell.

There are many blood channels, some of which are quite large and show intercommunication, giving the appearance of a telangiectasis. Many of the channels show no differentiated wall, the blood being present in clefts of the tumor tissue. Giant cells appear in these blood channels occasionally free or hanging by delicate fibrous filaments, or projecting from the wall into the lumen of the channel.

Sections from the capsule show a fibroblastic structure of varying stages of development up to hyalinization. The younger portions have a free blood supply. Externally, the fibroblastic tissue is found encroaching on the muscle, with little islands of atrophic muscle fibres enclosed by connective tissue. The inner surface of the

capsule has areas of typical tumor tissue and many small spicules of bone. The bone is enclosed by the fibroblastic cells, and much of it is of new formation. There is a slight infiltration of lymphocytes in and about the capsule. No extension of the tumor through the capsule is found, nor into the bone beyond the area of widening of the shaft.

After-history.—Following operation there seemed to be no loss of function; in fact, the patient noticed no difference in the use of the right arm from that of the left arm.

It is now three years since the operation and there is no evidence of recurrence or metastases. The patient has gained in weight and feels well. Röntgenological examination showed regeneration of the inner half of the clavicle from the periosteum that was left near the sternum.

Comments.—The literature of sarcoma of the clavicle centres around the name of W. B. Coley, whose careful reports and collection of cases comprise the great bulk of the subject matter extant. In 1910, Coley reviewed the literature mentioning 32 cases of Norkes in 1893, added 20 from the literature, and reported 12 cases not previously written up, making a total of 64 cases of sarcoma of the clavicle. Again in 1920, Coley added 32 cases found in print by Johansson and three cases under his observation, two cases reported by Kalus, and five of his own, making a total of 106 up to 1920.

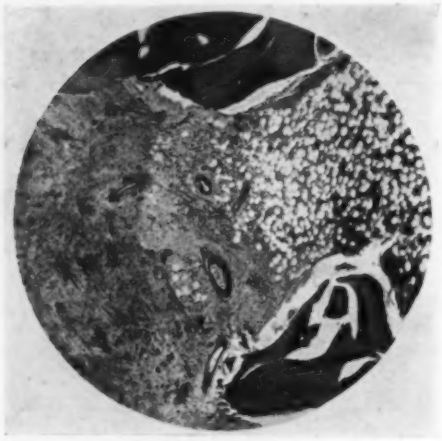

FIG. 3.—Section from near sterno-clavicular joint showing cartilage, fat, and tumor tissue. Two blood-vessels show in the section (x 40).

Of the 64 cases collected in 1910 only three were known to have been cured, one well for fifty years, one for ten years, and the third for five years. Since then four more cases treated by total excision plus Coley's mixed toxins of erysipelas and bacillus prodigiosus were reported as living: Delatour's case, five years; Coley's case, three years; Richardson's case, five years, and Huntington's case, four and one-half years.

Coley reports some very interesting cases—that of Freeman, a male, age twenty-three, who had a periosteal round-celled inoperable sarcoma which became operable following the use of toxins and X-ray and who was living ten years at the time the report was made; that of S. L., female, age twelve, a clearly operable case in which the value of radium was tested by five treatments together with X-ray. The tumor decreased in size but metastases formed in the lungs and the patient died within six months of the onset of the first symptom, no microscopic diagnosis having been made; that of Pincy of the Radium Institute of London, a female, sixty-two years of age, who had a large rapidly growing periosteal round-cell sarcoma in which operation was refused. The tumor was treated with radium and the patient was well two years later. He cites two of his own cases on the borderline of operability which were treated with radium and mixed toxins and followed by metastases and death in six months. One inoperable case (King's) was treated with radium and toxins, but the patient succumbed. One advanced case was given mixed toxins with no effect and death followed in six months. Three cases of periosteal round-celled sarcoma are reported, one of which

treated by excision and toxins resulted in a cure lasting nine years at the time the report was made; another similarly treated was well after twelve years, and one patient treated by excision and toxins died in a few months. Coley emphatically advises total excision and prophylactic after-treatment with mixed toxins in all cases.

Beatson, in 1902, reported a case of small round-cell sarcoma, the patient being alive and well two years after excision.

Sutton, in 1906, reported a patient well after seven months following partial excision.

W. Martin, 1921, N. B. Carson, 1911, F. W. Wunderlich and R. F. Fort have each reported a case of excision with no definite history of recovery for any stated period.

The most recent case appearing in the literature is reported by Coley in 1925, an endothelioma treated by total excision, toxin, and radium, but proving rapidly fatal.

FIG. 4.—X-ray showing tumor mass and periosteum reflected up on to it.

The records show very incomplete data as to microscopic pathology. This is most unfortunate considering the high mortality and the great discrepancies in the results of surgery, radium, X-ray and mixed toxin treatment.

Nine were round-celled sarcomas, some of which recovered; one spindle-celled died; and one angiosarcoma that was operated on became inoperable and probably died.

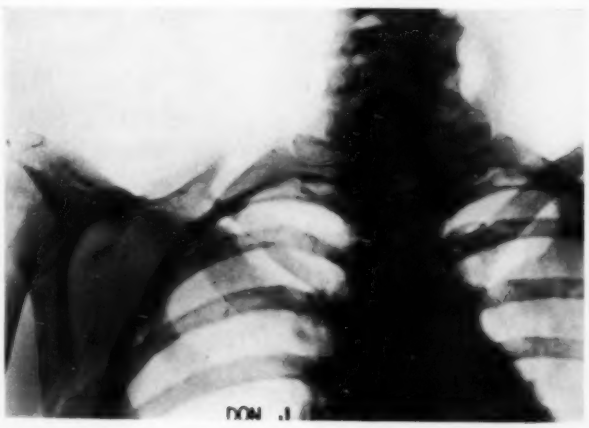

FIG. 5.—Röntgenograph taken September 13, 1927, showing regeneration of inner half of clavicle but no evidence of bone pathology.

Of the 106 cases reviewed by Coley we know of only seven cases that are living from three to fifty years.

Murphy emphasized the rareness of primary sarcoma of the clavicle in his summary of 797 cases of bone sarcomata collected from the literature in 1914. Of this number the clavicle was involved in only three-tenths of one per cent.

Credit for the first total resection of the clavicle for sarcoma is given by Coley to V. Mott in 1828, whose impression of the operation is best given in his own words: "This operation far surpasses in tediousness, difficulty and

danger anything that I have ever witnessed or performed. It is impossible for any description which we are capable of giving to convey an accurate idea of its formidable nature." History seems hazy on the subject of priority, for Remmer in 1732, Merean and D. Angerville, of Paris, in 1765, McCreary, of Kentucky, in 1811, and Meyer in 1823 are each said to be the pioneer.

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SOME UNDERLYING PRINCIPLES OF INTESTINAL SURGERY*

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The mechanical features of an operation are, of course, important, but when chief consideration is given to the kind of sutures used, to the pattern of the scissors and the shape of the forceps, they are unduly glorified. One of the great improvements in surgical technic was the introduction of absorbable sutures. This has been hailed far and wide as one of the big advances in operative surgery. Yet surgeons in certain prominent schools use silk almost invariably, thus showing that fine silk can be properly employed with satisfactory results. Even operative skill, as desirable as it is, may be emphasized over-much. There is such a thing as the operator being intoxicated with his own dexterity, which may on some occasions overbalance his best judgment of the procedure to be employed. These things are important—surely no one should deny the importance of operative dexterity—but they do not loom so large as they did in the pre-antiseptic era, and the increasing comprehension of modern physiology and biology has relatively diminished the importance of the mechanical features of an operation.

The normal function of any organ or viscus must be understood before an intelligent attempt at repair of its disordered function can be made. In the gastro-intestinal tract there are three more or less distinct functions, and a serious or prolonged interference with any one of them may result fatally: (1) The function of digestion, in which food is prepared and properly mixed with the secretions of the stomach and intestine, so that it is in a condition to be assimilated; (2) absorption, by which digested food is distributed through the lymph and blood-vessels to the bodily tissues; and (3) the function of peristalsis, by which the food is propelled from one part on the intestinal tract to another. This latter function overlaps and aids both digestion and absorption, and has other uses besides. For instance, Werelius, of Chicago, thinks that the cause of death in obstruction of the bowel is due to hepatic insufficiency, from stagnation of the portal circulation on account of the abolition of peristalsis by the obstruction; for the portal circulation depends largely upon the activity of the intestinal muscles.

Several decades ago all small intestines were supposed to look very much alike, and even differentiation in function was vague. Largely due to the work of Monks and others, we know that there is a different anatomical appearance of the upper small intestine from the lower ileum, and physiologists have pointed out that there is even a greater difference in function. Studies by Alvarez, Kline and others have thrown much light upon the motion of the small intestine. The beautiful moving pictures of intestinal

* Read before the Society of Alumni of Bellevue Hospital, New York, December 7, 1927.

peristalsis taken by Alvarez demonstrate his own views. According to Alvarez there is a gradation of peristalsis from the upper small intestine to the lower small intestine. Strips of muscle without nerve tissue from the upper jejunum when placed in oxygenated Locke's solution with strips from the lower ileum show a distinctly quicker rate of contraction.

Any extensive discussion of intestinal obstruction would carry us too far afield, and yet this condition cannot be ignored in considering the underlying principles of intestinal surgery, because upon the conception of obstruction depends the kind of treatment that must be given. It is well known that obstruction in the upper intestinal tract is more rapidly fatal than obstruction in the lower intestinal tract, even when the obstruction is of the same type. This has been partly explained by more rapid dehydration in high obstruction. In fact, some surgeons think that dehydration is the chief if not the only danger in high obstruction over the dangers of low obstruction. Doubtless, too, the more sensitive muscle in the upper small intestine may become exhausted from over-stimulation, whereas the slower, more phlegmatic muscle in the lower intestine may take things somewhat easier and so last longer.

It has been demonstrated that it takes a smaller degree of compression in the upper small intestine to produce an obstruction than in the lower small intestine or in the colon. This may be due to the fact that the increased sensitiveness and activity of the upper small bowel is more susceptible to pressure influences and resents irritation so that spasm may occur in addition to the mechanical pressure. At any rate it is clinically obvious that a degree of closure of the lumen of the bowel that would cause marked symptoms in the upper small intestine will produce but little disturbance in the colon or in the lower small intestine.

Intestinal obstruction has too frequently been considered as a general term without differentiation as to the type or locality of the obstruction. Aside from the well-known clinical fact that upper obstruction is more serious than lower obstruction, the type of obstruction has been often ignored. Foster and Hausler have done an excellent piece of work in calling attention to the radical difference between a simple mechanical obstruction due, for instance, to bands of adhesions or to a growth within the bowel, and an obstruction involving strangulation or interference with the vascular circulation of the intestine. The latter type, as a volvulus, is usually rapidly fatal and requires prompt surgical treatment, often demanding resection of the affected loop. The toxic material that appears to be formed within the bowel wall seems to resemble to some extent the histamine-like products that cause shock. This material produces profound symptoms,—a rapid weak pulse, fall in blood-pressure, vomiting, cold clammy skin, and many of the phenomena of shock. A simple mechanical obstruction, on the other hand, due to a band or to a growth from the bowel, causes some pain and increased peristalsis, but, as is well known in cancer of the colon, may gradually encroach upon the lumen of the bowel until there is complete obstruction for days without causing alarming symptoms. There is an intermediate type of cases

in which the segment of bowel that is involved is short, and in which there is not enough toxic material evolved by the comparatively small area of the bowel affected to produce sufficient toxic products to cause the shock-like symptoms of obstruction. Here there may be a combination between mild shock-like symptoms and the symptoms of mechanical obstruction. John A. Hartwell and his associates years ago pointed out that what is at first pure mechanical obstruction, as from a band, may from excessive peristalsis and distention involve the vascular circulation and so take on the features of strangulation. This is more likely to occur in the small intestine—particularly in the upper small intestine—than in the colon.

In post-operative obstruction due to lymphatic adhesions, the condition resembles at first the type of mechanical obstruction without strangulation of the bowel. After operations, however, the resistance of the patient may already have been lowered by the operation and the anæsthetic. The constant regurgitation and vomiting of liquid fecal matter will rapidly dehydrate the patient, as the obstruction is usually in the small bowel. A simple enterostomy with the insertion of a rubber catheter will often relieve the situation. Whether the enterostomy should be done low in the small bowel or high in the jejunum is a moot point. Following the teaching of Victor Bonney, Lee and Downes, Donald McRae and others, some surgeons have been advocating the performance of an enterostomy high up in the jejunum. But Orr and Haden in their experimental work emphasize the fact that dogs with experimental obstruction die sooner when the enterostomy is done high in the jejunum than if no enterostomy is done at all.

It would seem best to evacuate the bowel as near the site of obstruction as possible without too much manipulation. If there is a further obstruction on the oral side another enterostomy may be done higher up. As long as the enterostomy is done by the method of Coffey or of Witzel, with a soft rubber catheter, the danger of starvation with the enterostomy in the upper jejunum is avoided. The bowel should not be brought into the wound and opened freely for obstruction unless there is gangrene or marked impairment of the circulation in the loop.

The contents of the intestines also vary markedly from the duodenum and the upper jejunum to the ileum and colon. In the upper jejunum with its rapid action and quick emptying the contents are almost sterile. The antiseptic effect of the hydrochloric acid in the gastric juice is pronounced. Consequently the spilling of fecal matter in the upper small intestine is a question of not so great moment as in the lower small intestine or colon where the slightest soiling of the peritoneum with fecal matter may bring disaster.

These facts, then, indicate a relatively different biologic condition in the upper small intestine from what is found in the lower small intestine or in the colon, and it is necessary to fit our surgical technic accordingly. We may use different surgical materials, vary the instruments and the type of needles and clamps, but we cannot buck against the biologic laws governing living

tissue. It is essential in the upper small intestines to provide a good lumen because of the fact that obstruction here is not only more readily produced but is more rapidly fatal than in the lower bowel. Then, too, the fact that the contents of the upper small intestines are poor in bacteria or are almost sterile will permit the opening of the bowel in this region with comparative impunity. As to the relative merits of end-to-end or lateral anastomosis, if the end-to-end anastomosis can be performed with the same safety as lateral it is preferable. Undoubtedly the incision of the circular fibres in lateral anastomosis puts out of commission that segment of bowel so far as peristalsis is concerned, and it acts to a large extent as a foreign tube. Blake and Cannon have shown in experiments years ago that a bismuth meal in intestinal anastomosis on animals will pass through an end-to-end anastomosis satisfactorily, but that almost always there was a residue left in the segment in which a lateral anastomosis was done. In the course of time, however, the lateral anastomosis seems to rearrange itself in such a manner as almost to simulate the opening of an end-to-end union, so that the amount of material left within the site of this anastomosis is comparatively small. The chief danger of the lateral anastomosis is leaving pouches at the ends where material may accumulate and cause trouble. The stoma should be carried well toward each end, particularly toward the oral end of the bowel.

As the triangular space where the mesentery spreads to cover the bowel is rich in lymphatics and areolar tissue, it is important to avoid carrying infection to this region. The mesentery should be opened, clamped and tied well up to the bowel before the bowel is opened, and then it would be better to open the bowel from the mesentery toward the convex portion of the bowel. Even in the upper small intestine this precaution should be taken.

It is highly important in the upper small intestine to preserve the lumen, so here it would be best to do the operation by an open method, using soft-bladed clamps or rubber bands to prevent fecal flow, dividing and tying the mesentery and dividing the bowel from the mesenteric border outward somewhat obliquely in order to obtain maximum nutrition for the united ends. A row of continuous sutures is begun a short distance from the mesenteric border, passed as a mattress suture and tied on the lumen of the bowel. The mesenteric borders of the ends of the bowel are arranged so as not to be exactly opposite but to lie side-by-side. This suture is continued as a continuous mattress suture, is drawn quite snugly, and when a third of the bowel is sutured the mucosa of this third is whipped over with catgut or silk. This sutured mucosa eventually becomes necrotic and sloughs off, but in the meantime it protects the tissues of the mesenteric stumps while healing occurs and until the formation of granulations which possess some immunity against infection. The continuous mattress suture is then brought through to the surface and continued as a right-angle suture with an occasional backstitch, turning in just enough margin of the bowel to produce accurate approximation. Unless an occasional backstitch is taken the suture may have the effect of a basting thread and when tied act as a purse-string suture

and produce occlusion. With the bowel cut somewhat obliquely and turning in a small amount of diaphragm the lumen of the bowel is but little affected. The diaphragm is more along the mesenteric border, because here the bowel is thicker than at the opposite border. When the point of beginning of the suture has been reached, the thread is tied to the original end several times and cut short, and usually the knot withdraws into the bowel. If necessary an interrupted mattress suture may be placed to bury the knot for further safety. The material used is linen or silk. Chromic catgut may be employed, and there is doubtless no essential difference, but as the thread is usually sloughed off into the bowel and passes in this way, and as peristalsis is often active, it seems preferable to use a non-absorbable suture. By this technic the lumen of the bowel at the union is accurately adjusted and adequately preserved by the sutures applied so as to turn in no more diaphragm than necessary.

When the lower small intestine or the colon is reached different biologic conditions confront us and must be met by changes in technic. Here, as has been said, peristalsis is slower and complete mechanical obstruction is not so rapidly fatal, chiefly because there would be less dehydration than would occur in the bowel higher up. One of the most important points, however, is the septic contents of the bowel. In the lower small intestines and in the colon the fæces literally teem with bacteria and the slightest soiling of the peritoneum may be fatal from peritonitis. In this region, too, a lateral anastomosis will be less disturbing to the physiology of peristalsis than it would be higher up. The problem, then, is not so much the establishment of a large lumen with a small diaphragm as it is the avoidance of infection even with a diminished lumen.

The principle evolved by Kerr and Parker is in surgery of the lower small intestines and the colon of the greatest aid. As elsewhere, the mesentery should be divided and tied, and everything should be completed up to the point of opening the bowel. Then the well-known technic of Kerr may be instituted. The bowel is doubly clamped at the points of proposed resection and divided with the electric cautery. The ends to be anastomosed are buried with a continuous basting suture, usually of fine silkworm gut. It is best to place the clamps so that when the bowel is brought together the mesenteries of the two resected ends will not be opposite each other. As the bowel is doubly clamped and opened with the cautery there is not the same necessity for occluding the triangular spaces as there would be if the bowel were opened with scissors or knife. The two blind ends are brought together and sutured with continuous or interrupted sutures of linen or silk. It is possibly safer to apply a first row of interrupted mattress sutures which would approximate the under surfaces and to insert all of the sutures before tying any of them. Then a continuous suture can be placed in addition, continued around anteriorly and tied to its original end. After this is done any weak points are reinforced with an additional mattress suture and the omentum can be brought over the sutured area and attached by a few stitches.

Finally the basting sutures are removed and the lumen of the bowel is established by invaginating the intestine above and below the anastomosis with the finger and thumb.

If the mesentery is fat it is difficult to safely approximate the bowel in an end-to-end manner. Here the basting suture is made firm, the bowel is puckered up over it and the two ends of the basting stitch are tied together and buried with a purse-string suture, or another row of continuous mattress sutures may be placed over the basting stitch; which of these methods is adopted will depend upon the mobility of the tissues. When the tissues are thick and fat is abundant, it will be probably better to use the continuous suture than the purse-string. Then the two ends of the bowel are laid side-by-side and the lateral anastomosis is made. Here, too, the technic of Kerr may be utilized by using a narrow clamp such as the Barr clamp, clamping the portion of the bowel where the stoma is to be and opening it with the cautery and burying it with a basting stitch. A similar procedure is carried out on both ends of the bowel. The lateral anastomosis is made and the basting stitches are withdrawn. However, if the bowel can be packed off and the ends stripped of fecal matter, frequently the stoma may be made by an open incision and the suturing done as in a gastro-enterostomy. While this involves somewhat the danger of contamination, the contamination is on the smooth peritoneal surface and with care can be reduced to a minimum and is much less dangerous than in the areolar tissue of the mesenteric border of the bowel. It certainly would seem safer, however, to use the technic of Kerr for making the opening in the lateral anastomosis.

The end-to-end anastomosis with a fat mesentery means that when the sutures are passed through the mesentery they must be so tight in order to secure approximation that necrosis of the fat may occur and leakage result. With the ends of the bowel well turned in this danger cannot occur and the stoma will involve merely the smooth peritoneal surface of the intestine. By the adoption of this technic the many-stage feature of resection of tumors of the colon can often be avoided. For additional safety a small enterostomy with a rubber tube may be made in the lower part of the ileum in order to relieve the pressure of gas and liquid fecal matter and to give the bowel rest during healing. If the anastomosis is on the left side the insertion of a rectal tube will often relieve the pressure of gas.

In resection of the lower sigmoid and rectum, which is usually done for cancer, the problem again takes on a somewhat different phase. For cancer of the rectum or lower sigmoid, I have abandoned any operation except the radical operation, making an artificial anus in the region of the left iliac fossa. I recall a case where the cancer was apparently small and movable and situated about two inches above the sphincter. I removed it with the electric cautery. Histologically it was not unusually malignant. The patient suffered considerable pain during the convalescence; finally the sphincter action was regained, but within a few months there was a rapid recurrence for which no radical operation could be done. On the other hand, I have had

two extensive cancers in which the prostate was involved and the dissection was made from the bladder with the electric cautery in the process of radical operation. One of these patients was recently operated upon, and the other was operated upon over three years ago. There have been no recurrences in them so far.

While by no means an apostle of standardization, I believe that unless a growth is located well up in the sigmoid where resection and union of the ends can be made, a cancer in the rectum and terminal sigmoid always demands radical extirpation and a permanent abdominal anus. In this method the general principles of a combined operation are followed. The abdominal operation is first made, exploring the liver and the lymph-nodes of the abdomen to ascertain if there are metastases and whether a radical operation is justifiable. After dividing the mesosigmoid and the inferior mesenteric artery, the peritoneum is incised around the bowel and the cul-de-sac. The dissection is done with the hand first in the hollow of the sacrum and then on either side so as to avoid the ureters. The bowel is divided according to the method of Kerr and both stumps are inverted. The upper stump is brought out through an incision in the left rectus muscle and fastened with some sutures to the peritoneal side and to the sheath of the rectus. The lower stump is pushed down into the pelvis and the peritoneum is completely sutured over the pelvis. The abdominal wound is closed. The patient is placed in the dorsal position and a median incision is made as though a prostatectomy were to be done and the bowel is separated anteriorly down to the prostate. The incision is then carried to the tip of the coccyx, the fascia is opened and the dissection with the hand meets the dissection above. The levator ani and the structures on either side are clamped and divided and the bowel is removed. If there are any adhesions of the cancer at the base of the bladder these adhesions are left for consideration last and are dissected away with the electric cautery, sometimes taking a portion of the prostate and the seminal vesicles. This entire procedure is somewhat long, and is more difficult if done in one stage than in two stages. However, it would seem that the inevitable infection and the presence of cancerous material having access to the lymphatics is the objectionable feature of the two-stage operation. The shock that follows by doing all of this in one stage is, of course, a decided objection, but it may be usually overcome by administering a five per cent. or ten per cent. solution of glucose in Ringer's solution in the vein, giving it continuously as soon as the abdominal operation has been begun. In this way the blood-pressure may be kept up and by having a donor matched up, a transfusion can be performed immediately after the perineal part of the operation has been completed. I would not undertake a radical operation for cancer of the rectum in one stage unless there was at least one donor matched for a transfusion to be given immediately after the operation.

The abdominal stump is left for three or four days without being opened. At the end of that time a soft rubber catheter is inserted and the gas permitted to escape. Usually this is satisfactory for a few days longer, so

that the artificial anus is not fully opened until a week after the operation. In this way infection is avoided and solid healing may be obtained.

These observations are the result of my experience, and the steps are based upon tragedies in my own practice which I might have avoided by taking the precautions that I have just mentioned. The turning in of too large a diaphragm in intestinal resection of the upper jejunum has resulted in a fatality in my own practice. The leakage of sutures when placed in fatty mesentery in an effort to do an end-to-end anastomosis in the lower ileum has also caused a fatality. The attempt to carry out extensive procedures without provision for preventing shock, as has already been mentioned, has resulted in death of the patient. By following these general principles the mortality from intestinal surgery, particularly surgery of the lower intestine, can, I believe, be greatly reduced.

PROPHYLACTIC GASTROSTOMY*

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One of the distressing features following many abdominal operations, even after comparatively minor procedures, is the post-operative nausea and emesis. In most instances it is fortunately a mild and transient condition without serious consequences to the success of the surgical treatment. On other occasions the vomiting is protracted, and exhausting to the patient, and the pain produced in the wound may become intolerable without the administration of excessive amounts of opiates. After most of the radical operations in the upper abdomen, there is, as a rule, a temporary upset in the normal gastric and duodenal peristalsis. This causes a retention of contents in the stomach and often in the duodenum, and both may become distended with gases and liquids. Efforts to expel the abnormal contents by emesis are not always effective and repeated introductions of the stomach tube become unavoidable.

Anyone who has seriously considered the distress and pain produced by the passing of the stomach tube after a laparotomy, will agree that it is an abhorrent procedure from the viewpoint of the average patient. Many former patients, looking back over their sojourn in the hospital, have been heard to express the opinion that the stomach tube was the most disagreeable and painful part of their experience with the surgeon. The nauseating and choking sensation in the throat and the pain produced by the uncontrollable retching and pulling on the wound sutures combine to leave this unpleasant memory. Surgeons endowed with overly sympathetic temperaments have been known to avoid using the stomach tube, in response to the prayers and arguments of patients and friends, even when it was clearly indicated, and with harmful effects on the patients.

Safe and proper healing after any surgical operation depends for its success on perfect rest to that part of the body which has been incised and sutured. The required rest is hard to obtain when the operation has been made on a movable organ in the abdomen. Rest is hard to obtain, also, when the organ operated upon is subject to distention, deflation, and peristalsis, such as the case is with the stomach. Post-operative hemorrhage and leakage following gastric operations are invited and sometimes directly produced by a beginning gas distention and excessive pulling on the suture line.

It is for the purpose of calling attention to a prevention of some of these difficulties and complications, in suitable cases, that this article is prepared.

Temporary gastrostomy in operations for perforated gastric and duodenal

* Read before the Western Surgical Association, December 8, 1927.

ulcers is not a new form of treatment. Although no recent reference to the subject has been found in the literature, it nevertheless has been practiced and advocated in certain European clinics for the past twenty years or more.

Poissonier † in 1906 reported on its benefits in perforated gastric ulcer and mentioned two cases in which temporary gastrostomy alone seemed to have brought about cures of the ulcers. It was recommended by him particularly when the ulcer was located near the cardia. He termed it "gastrostomy of necessity" because it was applied originally in very desperate cases where no other surgery could be undertaken. He also referred to its prophylactic effect in regard to several complications following incisions and sutures in the stomach.

Lennander ‡ in 1908 stated the following indications for gastrostomy in a prophylactic sense:

1. In all cases of acute gastric dilatation where irrigation does not lead to its correction.

2. In cases of paralysis of the small intestine, and especially when the paralysis is high.

3. In operations for perforated ulcer of stomach or duodenum with pyloric or duodenal stenosis when gastro-jejunostomy is not possible.

4. In perforated ulcer operations when the ulcer cannot be closed, or where multiple ulcers are present.

5. In perforated ulcers where intestinal paralysis is likely to follow.

6. In cases where gastro-jejunostomy usually would be made but the patient's resistance contra-indicates its application.

Prophylactic gastrostomy has been a frequent procedure in a number of Swedish hospitals. While its main indication has been perforated gastric and duodenal ulcers, it has been used in other conditions also. Professor Key, of Stockholm, has performed it with good results in several cases of peritonitis from acute appendicitis.

Dr. T. Bratrud, of Warren, Minnesota, who first called my attention to this mode of treatment, recommends it from personal experience.

My first experience with the method was in one or two patients who were known to be intensely averse to the stomach tube, for reasons both mental and physical. They were cases in which at the time of operation, postoperative regurgitation was deemed inevitable. The encouraging results from this tentative application seemed to justify a wider use of the procedure, as the brief report following will indicate.

Very little has been stated about the technic of performing prophylactic gastrostomy. Professor Key places the tube through the anterior wall of the stomach some distance from the omental margin. It has seemed better to me to place it near the greater curvature. A fold of omental fat can then be fastened around the tube for two or three centimetres. This holds the

† Arch. Prov. de Chir., 1906, vol. xv, p. 421.

‡ Deut. Zeitsch. f. Chir., 1908, vol. xcii, p. 296.

stomach away from the abdominal wall and permits more freedom to gastric movements. A large falciform ligament has been utilized in some instances as additional protection between stomach and peritoneum.

A soft rubber tube, about the size of a No. 20 catheter, is placed into the stomach through a small stab wound near the omental margin 10 or 12 cm. from the pylorus. Two or more tannic catgut puckering sutures are inserted to infold the gastric wall. A rather deep infolding produces a valve action for prompt closing of the sinus when the tube later is removed. It should be kept *in situ* until it is entirely loose. Pulling on the tube while it is still attached to the gastric wall might evert the sinus and cause prolonged leakage. In our cases it has been removed from the ninth to the twelfth day. Normal gastric and duodenal peristalsis as a rule will be reëstablished after three or four days and the tube may be clamped permanently after its time of service is over.

The tube in the situation mentioned will be to the left of the linea alba. Although all our incisions in the epigastrium are made transversely, we have not placed the tube in the peritoneal wound, but passed it through a stab in the posterior aponeurosis a little to the left of the midline.

External fistulæ from the stomach, at least in the presence of fairly normal gastric secretion, do not cause the irritation to the wound and skin which often is so distressing in intestinal fistulæ. In some of our cases there was a slight seepage of gastric juice from the sinus after the tube loosened. In no such case was there any local reaction to the skin or to the patient's comfort. The seepage did not continue over four days in any case after the removal of the tube. The majority had no leakage whatever after the tube was out.

The immediate post-operative results to these patients have been very striking. There has been no epigastric distention and therefore much less pain requiring opiates. The patients have been permitted to drink water and, after the first hours, *ad libitum et ad desideratum*. This has been to their great satisfaction, and often entertainment, while watching and helping to control the outflow through the tube. Nausea has been present in some instances but to a less degree than in similar cases without gastrostomy. Emesis has rarely occurred; it has taken place only when the tube has been clamped too soon, or too long, and when it has been temporarily clogged. Because of the rapid and total escape through the tube of all the fluids swallowed, it is necessary to give large amounts of normal saline solution under the skin until peristalsis and absorption are reëstablished.

The greatest immediate boon to the patient has come through the non-use of the stomach tube. In several of our cases there was regurgitation of quantities of bile into the stomach. Formerly this signified much distress from retching and vomiting, and repeated seances with the stomach tube. With the gastrostomy tube *in situ* and unclamped, the swallowing of a few glasses of water would furnish a thorough gastric lavage and this procedure could

be repeated as often as desired, the patient often suggesting the proper time for washing the stomach.

Gastrostomy as a supplemental or prophylactic form of technic at the completion of other operations has been made in sixteen cases up to date. Three of the sixteen were operated upon for large, epigastric incisional herniæ following operations on the biliary tract through longitudinal incisions. It should be stated that all three had been operated upon originally by surgeons of modest attainments and moderate experience, which may account in part for the unfortunate breaking down of the wound and the wide separation of the aponeurotic margins.

Case I had been operated upon for gall-stones a few years previously and had a protrusion in the scar, the size of two fists. A subphrenic abscess had followed the operation and this had been drained through a thoracotomy with resection of the eleventh rib. At the place of the thoracotomy was a second, thoracic, hernia within which a section of the right lung played in and out at each respiratory effort.

Case II had suffered from protracted post-operative emesis after cholecystectomy. The wound had opened and attempts at secondary closure had been made. There was a wide hernial defect. The patient, a man of sixty-five years, also had intermittent attacks of intestinal obstruction with much pain and distention. It was found at operation that these attacks were caused by multiple, stenosing, intestinal adhesions. Several loops of the small intestine were incarcerated in the hernial sac. The unravelling and freeing of the intestine inflicted numerous traumatizations of the serosa and necessitated suturing of many denuded areas.

Case III had a massive hernia in the epigastrium, with a thin covering of scar tissue. A cholecystostomy had been made about a year previously. A sinus discharging pus and occasionally bile was located in the midline near the umbilicus. At operation this sinus was found to lead into a pocket of granulation tissue, the wall of which was made up largely from a loop of jejunum. Another open sinus from the gall-bladder formed a connection with this abscess cavity. Cholecystectomy was made and two feet of the jejunum, comprising the infiltrated and infected abscess wall, were resected.

After completing the intra-abdominal work in these three cases, extensive dissection of the epigastric wall was made before sufficient overlapping of fasciæ could be obtained to give reasonable hopes for permanent cures of the herniæ. In spite of all effort it was evident in all three cases that the main holding sutures were under considerable tension, even when the patient was narcotized. Experienced surgeons will understand readily the possibilities for regurgitation and overdistention under these conditions. Some may even remember instances when the post-operative straining caused damage to the wound and detracted from the expected success of the herniotomy. Gastrostomy was made in each of these cases and there was neither distention nor emesis after the operation. The entire period of recovery was uneventful and final results very good.

Case IV was an umbilical hernia of large size and long duration. After the incarcerated hernial contents, consisting of omentum, colon, and loops of small intestine, had been liberated, it was extremely difficult to replace them into the abdomen because of their volume and because of the decreased abdominal capacity. After finally succeeding in closing the hernia, gastrostomy was made and the post-operative troubles from distention were minimal.

Cases V and VI were operated upon for duodenal diverticula. The diverticulum in each case was located posteriorly and closely attached to the pancreas. Because of the difficult location, it was uncertain after removing the mucous membrane pouch, whether the opening had been closed properly, and fear was entertained that post-

operative paresis and overdistention might produce leakage and infection. Gastrostomy was made in each case and both the immediate reaction and the final results were gratifying.

Case VII was operated for an acute perforation of a duodenal ulcer. The opening in the duodenum was closed and reinforced with an omental tag and gastrostomy made. The leakage before operation had started a progressive peritonitis which raised havoc in the lower abdomen and, together with a pneumonic process, caused the patient's death six days later. The absence of all distention in the epigastrium during the entire time after the operation, was a striking feature. The autopsy showed the stomach and duodenum collapsed and the omentum holding tightly over the perforation, with no evidence of infection in this region of the abdomen.

Cases VIII, IX and X were chronic perforating duodenal ulcers near the pylorus. Pylorectomy was made in two of these, while in the third gastro-enterostomy with pyloric exclusion was performed. Prophylactic gastrostomy was made in all three. The convalescence in each case was exceptionally smooth.

Case XI had a fistula from the gall-bladder to the duodenum, requiring the excision of a rather large section of the duodenal wall in order to avoid placing the sutures in unhealthy tissue. The duodenal suture line seemed very feeble and gastrostomy was added as a precaution against possible overdistention. Recovery was easy and uneventful.

Case XII had had a cholecystectomy at a previous operation and was suffering from recurring attacks of pain associated with fever and jaundice. He had almost constant nausea, and frequent emesis, and showed marked emaciation. At operation the pancreas was found enlarged, the common duct distended and œdematous, but without stones. A choledochoduodenostomy was made. Because of the icteric and sickly appearance of the sutured structures, much concern was felt in regard to prompt and safe healing, especially since regurgitation and emesis had become habituated with the patient. Prophylactic gastrostomy was therefore made. In this and two of the following cases, the end of the gastrostomy tube was passed through the pylorus into the duodenum, and a small lateral opening was cut in the tube where it rested within the stomach. Soon after operation bile began to flow freely from the gastrostomy tube and it continued to do so for several days. There was no distention, no retching, and no vomiting. Healing was symptom free; the jaundice cleared rapidly and the recovery seems to be permanent.

Cases XIII, XIV, XV, and XVI, in which gastrostomy was made, were in patients who had been operated upon for visceroptosis, periduodenitis, and duodenal obstruction. Duodeno-jejunostomy was made in all four, and in addition some type of plastic fixation of ptosed viscera. In operations for visceroptosis, there is of necessity much handling and traumatizing of the abdominal viscera and temporary paresis, distention and regurgitation are to be expected during the first days after operation. The relief from distention, nausea, and emesis experienced by those operated upon and the greater assurance of physiologic rest and early healing of the visceral wounds have been outstanding features following gastrostomy in these four cases.

It is admitted that several of the patients on whom we made gastrostomy might have had just as good ultimate results if this technic had not been applied. But there were some on whom the multiple procedures undertaken would have been too hazardous for a one-stage operation without the use of the gastric safety valve under discussion. The comparatively much greater ease and comfort during the post-operative period have been such that the operation at no time has caused regrets, but always satisfaction. A conviction has grown that this additional surgery has not added to the operative risk, but that it has lessened it in each case. So far as it has been possible to

ascertain, no patient has had any symptoms to indicate late post-operative trouble from gastric adhesions at the place of gastrostomy.

From our limited experience we have been unable to formulate any statement as to possible contra-indications to this method, but we believe that its application has a wide field of usefulness in many types of abdominal operations.

If this technic should become as satisfactory to other surgeons as it has been to me, it would seem advisable to give it a distinctive name in order to differentiate the gastrostomy in this prophylactic sense from gastrostomies made for other reasons. For approval, the term *prophylactic gastrostomy*—or *gastrostomia prophylactica*—is herewith suggested.

OBSERVATIONS ON PEPTIC ULCER* (*Continued*)

V. FINDINGS IN EXPERIMENTALLY PRODUCED PEPTIC ULCER: ETIOLOGIC AND THERAPEUTIC CONSIDERATIONS

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In the following experiments the formation of typical chronic peptic ulcers was induced in the stomach, duodenum and jejunum of dogs by several different procedures. Certain common factors, however, were present in all the procedures. After typical chronic ulcers had been produced, the factors which caused their formation were neutralized or removed and prompt healing of the ulcers ensued. In gross and microscopic characteristics, in the manner in which their formation was induced and in the manner in which their healing was accomplished, the experimentally produced ulcers were similar in many ways to peptic ulcers encountered in man. The ulcers in these experiments, therefore, will be discussed in their relation to the etiology and treatment of clinical cases of peptic ulcer.

In previous papers I have compiled bibliographies and reviewed the work of former investigators in this field. Only a few will be mentioned here for the purpose of calling attention to certain conceptions of peptic ulcer which have been generally accepted.

Bolton, Greggio, Ivy, Butsch, Durante, Rosenow and others have compiled bibliographies on the work of previous investigators, among the earliest of whom were Celsus, Bauhin, Lebert, Baille and Virchow. Cruveilhier, early in the nineteenth century, was one of the first to make a complete study of the morbid appearances, complications and sequelæ, clinical history, and rational treatment of the disease.

The economic importance of peptic ulcer is made apparent by a study of statistical data. Robertson and Hargis, from an analysis of 2000 necropsy protocols, found that ulcers or scars of ulcers occurred in 18.9 per cent. of cases. Of these 7.05 per cent. were gastric and 11.8 per cent. duodenal. In 7 per cent. of cases of ulcer both the stomach and duodenum were involved. The ratio of males to females affected was three to one.

Certain criteria have been generally accepted in distinguishing acute and chronic ulcers. An acute ulcer has a fresh appearance as if erosion had occurred rapidly and cleanly. The crater is usually cone-shaped with the apex in the base of the ulcer. Microscopically the acute ulcer is sharply defined and the surrounding tissues are healthy and normal. Evidences of

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epithelial proliferation are usually apparent at the margins. An acute ulcer, if undisturbed, heals rapidly and cleanly in a surprisingly short time.

A chronic ulcer, however, has a very different appearance. It has a sluggish looking punched-out crater which is usually cone-shaped but with the apex toward the mucosal surface. The edges overhang and the margins and base are dirty, necrotic and indurated. The surrounding mucosa usually shows a varying degree of chronic inflammation and is covered with mucus. Microscopically the chronic ulcer shows extensive inflammatory infiltration of the margins. The submucosa is wedge-shaped with the thick portion of the wedge toward the ulcer crater and the apex gradually merging into the normal submucosa some distance from the ulcer. The chronic ulcer usually shows evidence of extension rather than healing.

In between the extremes of acute and chronic ulcers are lesions exhibiting characteristics of both. They are subacute ulcers and probably represent the transition from an acute to a chronic lesion.

Acute ulcers occur not only spontaneously with certain diseases such as acute infections, fevers and toxæmias, but may be produced experimentally in many ways. Butsch, Greggio and Bolton have compiled bibliographies in this field and Greggio has divided the methods into several groups. These I have reviewed in a previous paper.

The means of producing chronic ulcers in experimental animals, however, are as few as those of making acute ulcers are numerous. Mann has gone so far as to say: "Chronic peptic ulcers appear to have never been consistently produced experimentally in the gastric mucosa by any method."

Acute ulcers which under normal conditions and in spite of most experimental conditions heal rapidly have in some cases been retarded in healing. A few investigators have produced lesions in the stomach or duodenum of experimental animals that are similar in some respects to the peptic ulcer found in the stomach and duodenum of man. Bolton, Friedman and Hamburger, Ivy, Turck, Greggio, Vedova and Durante, Bedarida, Dott and Lim, Exalto, Kehrer, Dragstedt and Vaughan, Rosenow, Hoffman and others have reported the production of such ulcers.

Probably the most successful method of producing peptic ulcers in experimental animals has been reported by Mann and Williamson. They shunted the alkaline bile and pancreatic juices and the alkaline secretion of the duodenum into the lower ileum where the alkali could not serve to neutralize the acid gastric juice. In their experiments ulcers were produced by this method in the duodenum and jejunum of dogs in more than 90 per cent. of cases. Such ulcers were grossly and microscopically almost indistinguishable from peptic ulcers found in the duodenum of man. In their experiments, however, no gastric ulcers were found.

Many investigators (Pavy, Ziemmsen, Leube, Cramer, Quincke and Daettwyler, Cohnheim, Griffini and Vassale, Matthas, Bolton, Ivy, Mann and others) have studied the healing process in experimentally produced ulcers. Mann has studied the healing of large numbers of ulcers produced by his

method of surgical duodenal drainage and healed by gastrojejunostomy and pyloric exclusion which completely protected the ulcers from any exposure to acid chyme. He has observed that first there was a cleansing of the base of the ulcer. Slough separated and a protecting coat of serum and coagulum formed over healthy granulations, these processes taking usually about four days. Simultaneously the mucosa began to grow out from the edges as a thin layer of epithelial cells. The edges of the mucosa seemed to overhang and granulations pushed up in the centre so that the growing edge of mucosa was protected in the resulting depression. This initial stage, occupying about ten days, decreased the area to be healed. Once initiated the healing, if undisturbed, was rapid. In twenty days three-fourths or more of the base of a large ulcer was covered with epithelium and in thirty days the lesion was entirely healed. Often the scarring that remained was hardly noticeable. Recently Kennedy and Caylor, in clinical cases of duodenal and gastric ulcer respectively, have found healing lesions that were strikingly similar to healing experimental ulcers as described by Mann. As Bolton has suggested, any agent which retards the healing of an ulcer causes scarring, thickening and induration, giving the ulcer a punched-out appearance.

Many hypotheses regarding the etiology of peptic ulcer have been advanced, but their very multiplicity is proof of their inadequacy. Greggio has divided them into several groups according to their physiologic and pathologic basis and I have referred to them in a previous paper. Although certain theories may explain certain individual cases of ulcer they do not solve the real problem, the chronicity of peptic ulcer.

In the study of experimental ulcer two facts seemed to stand out: First, all acute lesions produced in the normal stomach healed very rapidly and readily and, second, the method of surgical duodenal drainage described by Mann and Williamson induced the formation of ulcers in the duodenum and jejunum of dogs in more than 90 per cent. of experiments. I then conceived the idea of making acute lesions in the stomach of dogs and at the same time performing the operation for surgical duodenal drainage in order to determine whether the stomach would still heal with its usual rapidity and completeness. In later experiments I also carried out other procedures, some of them in conjunction with surgical duodenal drainage, in order to study various other phases of the production and healing of peptic ulcer.

Methods of Experimentation.—Normal healthy dogs were used in all experiments, and for all operative procedures ether anæsthesia and aseptic technic were employed. No rubber-covered or other intestinal clamps and no unabsorbable sutures were used in any of the operations, all of which were performed by me. In the experiments the more important of these operative procedures were carried out either singly or in various combinations.

Acute lesions were made in the stomach by excising certain areas of the gastric mucosa through an incision in the anterior wall of the stomach. Selected areas of mucosa were lifted with Allis forceps and excised with sharp scissors so that four circular areas of gastric wall, about 2 cm. in

diameter, were left denuded of mucosa. Hemorrhage was sometimes profuse for a few moments but always stopped spontaneously. In no case was any suture or ligature applied to vessels in these areas and no case of secondary hemorrhage was encountered.

The operation for establishing surgical duodenal drainage was performed as follows: The pylorus was severed, the distal cut end closed, the first portion of jejunum was severed and the proximal cut end closed. The proximal cut end of pylorus was joined to the distal cut end of jejunum by end-to-end anastomosis, the continuity of the gastro-intestinal tract being thereby reëstablished. The closed segment of intestine consisting of the duodenum and a small part of the first portion of the jejunum was drained into the ileum by side-to-side anastomosis at a point about 25 cm. proximal to the cæcum.

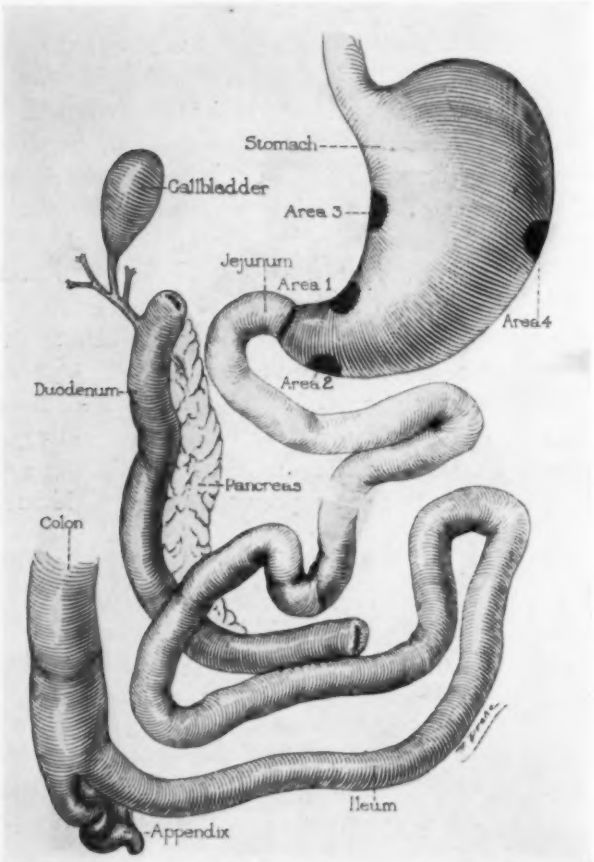

FIG. 1.—Diagram of operation for surgical duodenal drainage. Shaded areas in stomach denote those denuded of mucosa in Groups 1, 3 and 4.

Patches of jejunum of whole thickness and with intact mesenteric circulation were transplanted into various sites in the wall of the stomach in the following manner: Each patch was obtained by resecting a loop of jejunum about 5 cm. in length. Care was taken not to injure the mesenteric vessels of the resected loop which was split longitudinally opposite its mesenteric attachment and trimmed to a circular shape about 5 cm. in diameter. The patch was then sutured into the gastric wall so as to lie flat and replace a resected portion of gastric wall of the the same size and shape. The continuity of the gastro-intestinal tract was reëstablished by end-to-end anastomosis of the ends of intestine from which the patch was obtained. No more than one patch was transplanted in a single stomach.

The röntgenologic examinations made in some experiments were carried

out under essentially the same conditions that obtain in similar examinations of the gastro-intestinal tract in man. After a fasting period of from twelve to twenty-four hours, opaque meals consisting of equal parts by weight of barium sulphate powder, gum acacia solution of syrupy consistency and condensed milk were administered to the dogs in the proportion of 15 gm. of the mixture for each kilogram of body weight. Immediately after the ingestion of the meal, and at intervals of two, five and seven hours, fluoroscopic examinations and röntgenograms were made.

Gastro-enterostomy in these experiments was performed anteriorly, about 5 cm. proximal to the pylorus and in the isoperistaltic direction. Experience with dogs has shown that this method gives the best results functionally.

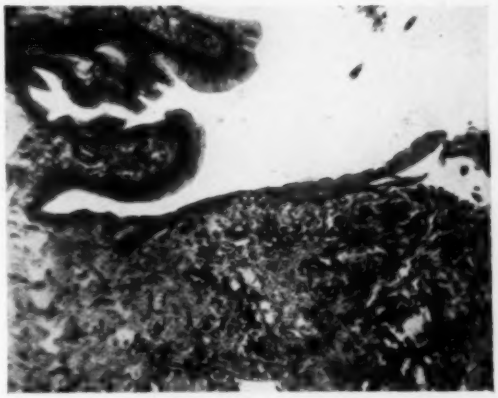

FIG. 2.—Growing edge of mucosa in healing area in a stomach in Group 1. Four days after operation (x 150).

Results.—GROUP 1.—*Excision of Areas of Mucosa Alone and Areas of Mucosa and Muscularis in the Normal Stomach and Duodenum.*—There were eight experiments in this group. Denuded areas were made in the duodenum just distal to the pylorus and in four sites in the stomach (Fig. 1). All areas were about 2 cm. in diameter. In the stomach areas 1 and 2 were on the lesser and greater curvatures, respectively, about 3 cm. from the pylorus, and areas 3 and 4 were midway along the lesser and greater curvatures, respectively. Denuded areas were examined at various intervals from eight to fifteen days after they were made, either after the animal had been killed under anæsthesia or after the portion of the tract containing the denuded areas had been resected.

In all cases the denuded areas healed rapidly and cleanly. From the relative sizes of the lesions in the stomach at various intervals it appeared that areas on the lesser curvature healed a trifle more slowly than those on the greater curvature. Healing in the pyloric region was a little slower than in the fundus. All areas, however, healed so rapidly that in two weeks epithelium covered the entire area denuded of mucosa at operation. Scars were small and often hard to find. There was no appreciable difference in healing in areas from which mucosa alone or both mucosa and muscularis had been denuded. By microscopic study of the specimens, healing was found entirely similar to that described by Mann and others and previously mentioned (Fig. 2).

GROUP 2.—*Surgical Duodenal Drainage.*—There were twenty consecutive experiments in this group. In each case the duodenum with intact circulation and bile duct and pancreatic ducts attached was resected, closed at both ends

and anastomosed so as to drain all the alkali of the bile, pancreatic juices, and its own secretion into the ileum. The jejunum was attached to the stomach so that anatomically it replaced the duodenum. The alkali was drained into the ileum so far distal to the pylorus that the possibility of regurgitation of alkali, as far as the stomach or jejunum into which it emptied was precluded (Fig. 1). Digestive processes, however, continued and apparently were not hindered by the altered anatomic conditions. This was proved by the fact that dogs usually remained in good condition after operation. A

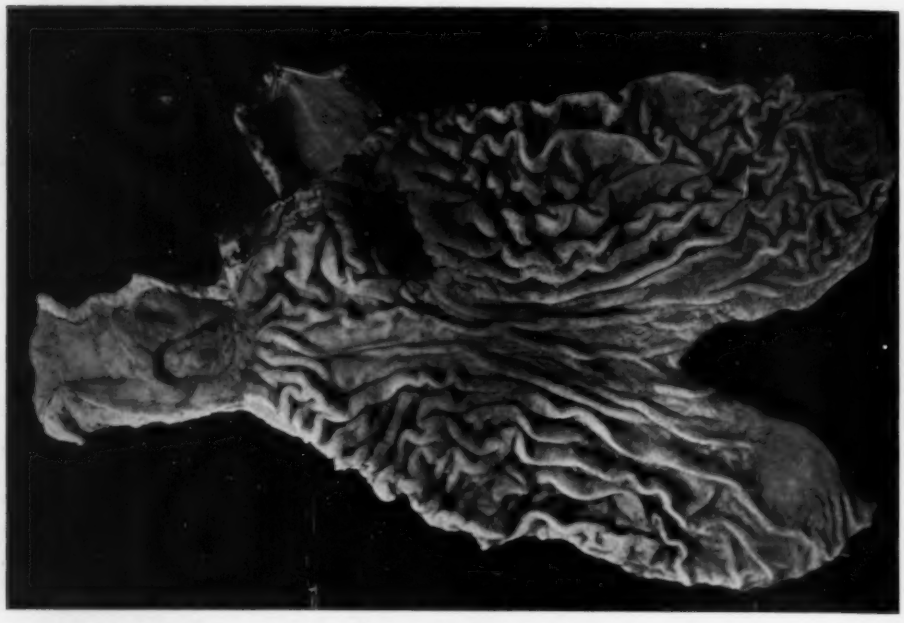

FIG. 3.—Typical chronic ulcer in jejunum induced by surgical duodenal drainage in Group 2. Thirty-one days after operation.

mixture of milk and corn syrup added to their regular diet was the only way in which their care differed from that of normal dogs. No nutritional disturbance occurred until the ulcer, developing at the usual site in the jejunum following surgical duodenal drainage, attained a considerable degree of chronicity. Loss of weight when it occurred seemed to be attributable to the ulcer rather than the cause of it.

In all of the experiments typical subacute and chronic ulcers developed in the jejunum at the usual site. They were found in the jejunum from 0.5 to 2 cm. distal to the line of anastomosis with the stomach and at the point where the acid chyme emptying from the stomach impinged directly against the wall of the intestine. Bleeding and perforation frequently occurred with these ulcers. The earliest ulcer in the group was found fourteen days after operation. The last dog in the group died from peritonitis from perforation of a typical ulcer four months after operation. All the ulcers found in this group were characteristically subacute and chronic and were grossly and microscopically almost indistinguishable from peptic ulcers found in the

duodenum of man (Fig. 3). Gastric ulcers were never found in these or any other experiments in which surgical duodenal drainage alone was instituted.

GROUP 3.—*Four Areas in the Stomach Denuded of Mucosa and Surgical Duodenal Drainage Established at the Same Operation.*—In twenty-eight experiments areas were denuded in the stomach as in Group 1. At the same laparotomy surgical duodenal drainage was established in the same way as in Group 2 (Fig. 1). Eight experiments were discarded because of post-

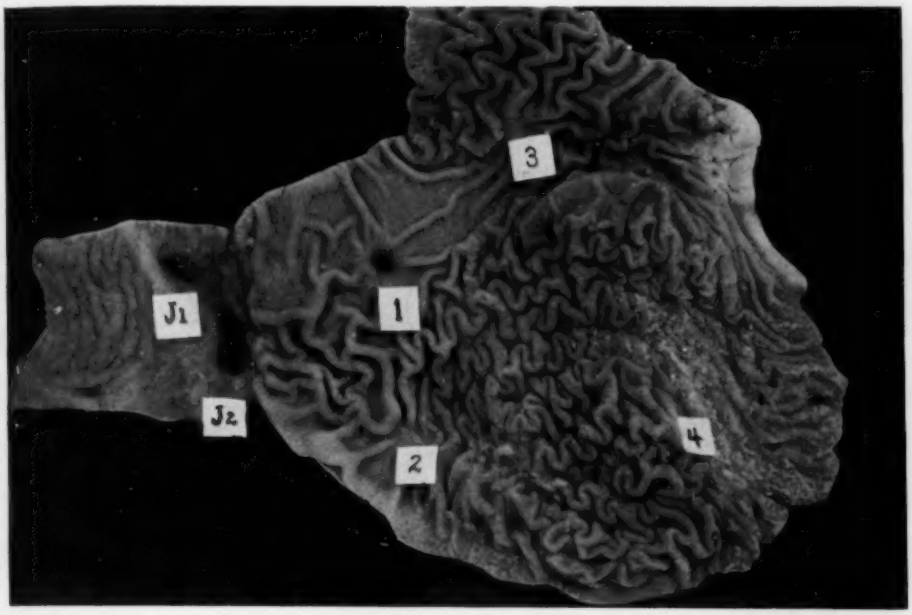

FIG. 4.—Typical chronic ulcer in stomach at area 1, induced by the procedures of the third and fourth groups. Small ulcer at area 3. Lesions at areas 2 and 4 entirely healed. Thirty days after second operation (Group 4).

mortem changes and other extraneous circumstances which marred some of the specimens. Data in the twenty remaining experiments were complete and satisfactory. The shortest experiment lasted four days and the longest ninety-five days. In every experiment there was marked delay in healing of denuded areas in the stomach. Excluding two experiments of less than a week's duration, there were eighteen which lasted for long periods. In 50 per cent. of these, healing was not only very much delayed but definite ulcers formed in areas 1 and 3 on the lesser curvature of the stomach. These were grossly and microscopically typical subacute and chronic peptic ulcers (Fig. 4).

Delay in healing was much more marked on the lesser curvature than on the greater. Frequently in the same stomach typical chronic ulcers were found in areas 1 and 3 on the lesser curvature while healing or completely healed scars were found in areas 2 and 4 on the greater curvature (Fig. 5). Healing in area 2 in the pyloric region of the greater curvature was not so rapid as that in area 4 in the middle region of the greater curvature which

healed more rapidly than any other site in the stomach. In two experiments small ulcers were found in area 2 in addition to large ulcers in areas 1 and 3 on the lesser curvature. Except for these two associated ulcers, all ulcers found in the experiments occurred on the lesser curvature of the stomach.

All gastric ulcers were typically subacute and chronic. One of them perforated and caused the animal's death from peritonitis. Others had perforated all coats of the gastric wall and were prevented from communi-

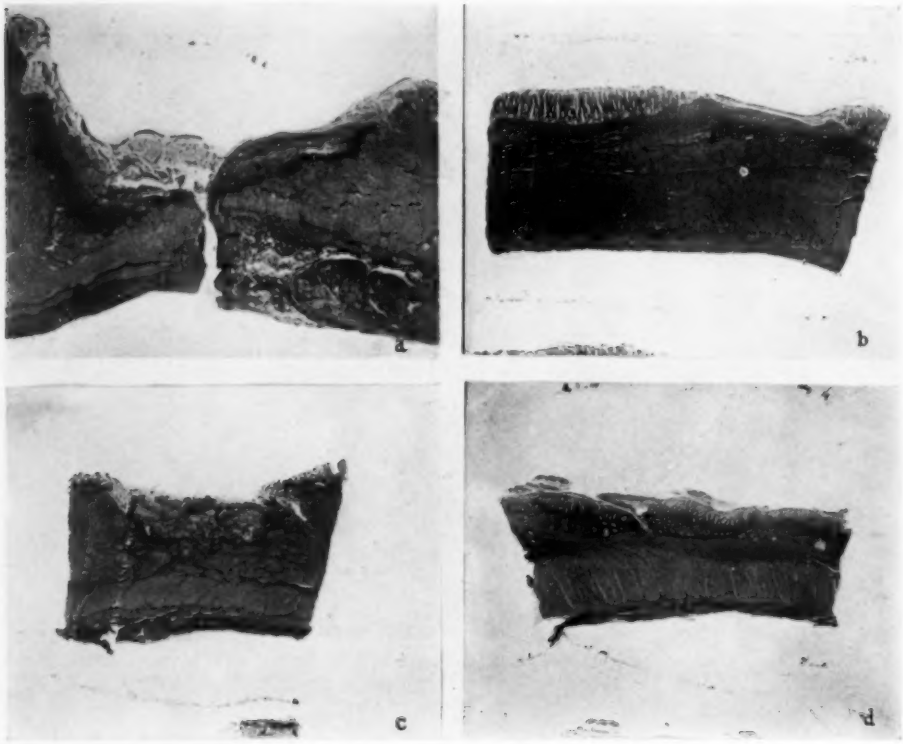

FIG. 5.—Typical sections of four areas in a stomach (Group 3) twenty-six days after surgical duodenal drainage (x 8). a. Area 1, ulcer that perforated. b. Area 2, healing. c. Area 3, small ulcer. d. Area 4, healed.

cating with the general peritoneal cavity only by adhesions with the omentum or other tissues. The oldest of the gastric ulcers was one found thirty-five days after operation. The dog died from peritonitis from perforation of the jejunal ulcer at the usual site. Besides the lesions described in the stomach, ulcer formed in practically all animals at the usual site in the jejunum following surgical duodenal drainage; the frequent perforation of such ulcers was the reason that more experiments of long duration were not available in the group.

GROUP 4.—*Surgical Duodenal Drainage Established and Four Areas in the Stomach Denuded of Mucosa Two Weeks Later.*—The experiments in this group were essentially the same as those in Group 3, except that areas in the stomach were not denuded of mucosa until two weeks after the estab-

lishment of surgical duodenal drainage. This interval between the two operations was tried because it had been found that ulcers in the jejunum following surgical duodenal drainage rarely formed earlier than two weeks. On the assumption that the same factors both induced the formation of ulcer in the jejunum and delayed the healing of areas in the stomach with subsequent formation of ulcers on the lesser curvature, it was hoped by the interval between operations to subject denuded areas in the stomach to the hypothetical factors at a time when they had been found to induce ulceration in the jejunum in almost 100 per cent. of experiments.

There were twenty consecutive experiments in all of which the data were complete and satisfactory. The earliest observation on the stomach was two

Table 1

Series of jejunal patches

Dog	Patch placed in stomach, date of operation	Situation of patch in stomach	Patch explored, date of operation	Condition of patch	Time interval, days
1	1-30-25	Lesser curvature near pylorus	3-25-26	Normal	419
2	7- 9-25	Lesser curvature near pylorus	2- 1-26	Normal	175
3	7-27-25	Lesser curvature near pylorus	2- 1-26	Normal	157
4	7-27-25	Lesser curvature near pylorus	2- 1-26	Normal	157
5	7-28-26	Lesser curvature near pylorus	1- 7-26 (Death, cause ?)	Ulcer on patch 1.5 by 1 cm.	163
6	7-28-26	Lesser curvature near pylorus	9- 2-25 (Death, cause ?)	Normal	36
7	7-29-26	Lesser curvature near pylorus	2- 4-26	Normal	190
8	8- 7-25	Lesser curvature near pylorus	2- 4-26	Normal	181
9	9- 7-25	Lesser curvature near pylorus	1-20-26	Normal	135
10	9- 7-25	Lesser curvature near pylorus	1-22-26	Normal	137
11	9- 7-25	Lesser curvature near pylorus	1-25-26	Normal	140
12	9- 9-25	Lesser curvature near pylorus	1-25-26	Normal	138
13	9- 9-25	Lesser curvature near pylorus	1-20-26	Normal	133
14	9- 9-26	Anterior wall near pylorus	6- 7-26	Normal	90
15	9-10-26	Anterior wall near pylorus	6- 7-26	Normal	89
16	9-10-26	Middle of anterior wall	6- 7-26	Normal	89
17	9-11-26	Middle of posterior wall	6-10-26	Normal	91
18	9-18-26	Middle of posterior wall	6-10-26	Normal	84
19	9-23-26	Middle of greater curvature	7- 1-26	Normal	100
20	9-23-26	Anterior fundus region	6-11-26	Normal	80
21	9-23-26	Anterior fundus region	6-11-26	Normal	80

days after operation and the latest ninety days. In every experiment the areas in the stomach denuded of mucosa and situated in the usual four sites showed delay in healing. Delay in healing was much more marked in areas 1 and 3 on the lesser curvature than in areas 2 and 4 on the greater curvature. Excluding four experiments of less than a week's duration, there were sixteen which lasted for long periods. In 62.5 per cent. of these, not only was healing much delayed but definite ulcers formed in areas 1 and 3 on the lesser curvature of the stomach. These were grossly and microscopically typical subacute and chronic peptic ulcers similar to those in Group 3 and almost indistinguishable from peptic ulcers of the stomach encountered in man (Fig. 4). All the ulcers in this group were found on the lesser curvature of the stomach, the oldest of them having been found two months after operation.

GROUP 5.—*Patch-transplants of Jejunum in the Normal Stomach for Long Periods.*—Patches of jejunum of whole thickness and with intact

mesenteric circulation were transplanted into several different sites in the gastric wall of twenty-one dogs (Table I). Patches in the anterior and posterior walls and in the lesser and greater curvatures were observed for long periods varying from thirty-six to four hundred and nineteen days. In all experiments except one, all patches remained normal. In this experiment a patch transplanted into the lesser curvature of the stomach ulcerated superficially one hundred and sixty-three days after the patch had been transplanted.

GROUP 6.—*Patch-transplants of Jejunum Following Surgical Duodenal Drainage.*—In thirteen dogs from the preceding group patches of jejunum which had remained normal for long periods, from eighty to four hundred nineteen days, were studied following surgical duodenal drainage (Table II).

Table 2

Series of jejunal patches after duodenal drainage

Dog.	Jejunal patch		Duodenal drainage, date of operation, 1926	Date of necropsy 1926	Condition of patch	Time interval, days	Ulcer in jejunum
	Situation in stomach	Duration, days					
1	Lesser curvature near pylorus	419	3-25	6-22	Normal	89	No
2	Lesser curvature near pylorus	175	2- 1	4-19	Ulcer 2 by 1.5 cm.	77	No
3	Lesser curvature near pylorus	157	2- 1	3- 3	Ulcer 2 by 1.5 cm.	30	Yes,1 by 1 cm.
4	Lesser curvature near pylorus	157	2- 1	3-12	Two ulcers, one perforated	39	Yes,2 by 1 cm.
5	Lesser curvature near pylorus	190	2- 4	3- 5	Normal	29	Yes,1.5 by 1.5 cm.
6	Anterior wall near pylorus	90	6- 7	7- 5	Normal	28	No
7	Anterior wall near pylorus	89	6- 7	7-30	Normal	47	Perforating ulcer 1 cm.
8	Middle of anterior wall	89	6- 7	7- 5	Normal	28	Perforating ulcer, 3 by 2 cm.
9	Middle of posterior wall	91	6-10	7-30	Normal	50	Yes, 1 by 1.5 cm.
10	Middle of posterior wall	84	6-10	7-30	Normal	50	Yes, 3 by 3 mm.
11	Middle of greater curvature	100	7- 1	7-30	Normal	29	Yes, 8 by 8 mm.
12	Anterior fundus region	80	6-11	6-18	Normal	7	No
13	Anterior fundus region	80	6-11	6-29	Superficial erosion	18	Yes, 2.5 by 2 cm.

That patches were normal was determined by direct inspection at the laparotomy at which surgical duodenal drainage was established. Patches in various situations in the stomach were studied at intervals from seven to eighty-nine days following surgical duodenal drainage. Except for a superficial erosion in a patch on the anterior wall in one experiment, ulcers were found only in patches situated in the lesser curvature. Typical chronic peptic ulcers developed in three of five experiments in which patches had been transplanted into the lesser curvature of the stomach (Fig. 6). Surgical duodenal drainage induced formation of ulcer in patches of jejunum on the lesser curvature; patches in other situations in the stomach remained normal.

GROUP 7.—*Röntgenologic Examinations of Ulcer of the Jejunum Induced by Surgical Duodenal Drainage.*—Twelve normal dogs, on several different occasions, were given opaque barium meals for fluoroscopic examination and röntgenograms of their gastro-intestinal tracts. Röntgenologic findings were very constant in all cases and demonstrated that the gastro-intestinal tract of

the dog could be examined röntgenologically with considerable ease and precision. The shape of the dog's stomach was found slightly different from that of man, but in other respects the stomach and duodenum conformed very closely to their röntgenographic appearance in man.

Of the twelve animals studied as normal controls, six were studied röntgenologically at weekly intervals for ulceration following surgical duodenal drainage (Table III). In every one of the animals an ulcer appeared at the usual site of ulceration in the jejunum following surgical duodenal drainage (Fig. 7). Of the six ulcers three were typically chronic in type and

Table 3 [redacted] Synopsis of protocols of six animals examined for ulcer formation

Dog	Date of operation	Number of examinations roentgenologic	Roentgenologic examination: Date	Roentgenologic examination: Findings	Exploratory laparotomy: Date	Exploratory laparotomy: Findings	Date of death	Necropsy, findings	Remarks
H 812	4- 8-25	7	5- 7-25 6-15-25	Suspicious of ulcer. Definite ulcer.			7-13-25	Large, typical chronic ulcer that had caused death by perforation.	Typical chronic ulcer diagnosed by roentgen ray and verified at necropsy.
I 24	4-23-25	7	5-27-25 6- 7-25	Suspicious of ulcer. More suspicious.			6-18-25	Subacute ulcer that had caused death by perforation.	Subacute ulcer suspected by roentgen ray and verified at necropsy.
I 25	4-23-25	2	5-29-25	Stomach tremendously dilated; ulcer surmised.			6-12-25	Subacute ulcer that had caused death by perforation.	Subacute ulcer suspected by roentgen ray and verified at necropsy.
J 99	4-26-26	9			6-17-26	No ulcer present and entire gastro-intestinal tract apparently normal.	7-1-26	Ulcer that had perforated in the acute developing stage and caused death.	Acute ulcer. Roentgen ray and exploratory laparotomy failed to find the ulcer which no doubt developed only a few days before death.
J 118	4-26-26	9	5-26-26 6- 2-26 6-28-26	Definite ulcer. Ulcer grown larger. Ulcer smaller and less distinct.	6-3-26 6-17-26	Large chronic ulcer. Ulcer grown larger (gastro-enterostomy performed)	7- 2-26	Perforating acute ulcer opposite the gastro-enter stoma. Original ulcer diagnosed by roentgen-ray had healed considerably	Typical chronic ulcer diagnosed by roentgen-ray and verified by exploration. Partially healed as seen in roentgen ray, verified by necropsy.
J 167	5- 4-26	3	5-26-26	Definite ulcer.	6-3-26	Large chronic ulcer that had apparently perforated within 2 or 3 hours preceding exploration. Gastro-enterostomy performed in the hope of saving animal. Perforation closed.	6-4-26	Considerable peritonitis as found at exploration. Large perforating ulcer as repaired at exploration.	Typical chronic ulcer diagnosed by roentgen-ray and verified by exploration and necropsy.

each of them was diagnosed by Röntgen-ray. Two others were of the subacute type and although suspected at fluoroscopic examination, were not depicted with certainty in the röntgenograms. One was an acute ulcer that apparently formed after the last röntgenologic examination and just before the animal's death. It has been found in a few experiments in a large series that the usual chronic ulcer does not appear after surgical duodenal drainage, but instead an acute ulcer forms very rapidly and perforates within a few hours from the time of its first appearance.

In one animal in which a large, crater-shaped, indurated ulcer was demonstrated röntgenologically and at exploration, the stomach was anastomosed to a loop of jejunum about 50 cm. distal to that containing the ulcer. A large stoma was made in order that the greater part of the gastric contents might empty through it. Following this operation the large ulcer just distal to the pylorus became much smaller and more difficult to depict röntgenologically. At necropsy, fifteen days later, this ulcer had lost its induration and deep, crater-like shape, and had healed considerably.

Until the actual formation of ulcer there was no appreciable difference in the röntgenologic characteristics of the gastro-intestinal tract of the dogs before and after surgical duodenal drainage. Contractions of the stomach seemed entirely unchanged both in rhythm and character. After ulcer had formed there was sometimes a slight tendency toward stasis which seemed to be the result of the ulcer. In one experiment stasis of a considerable degree followed the formation of ulcer.

GROUP 8.—*Healing of Chronic Ulcers After Gastro-enterostomy.*—The operation for surgical duodenal drainage was performed in nine healthy, nor-

FIG. 6.—Stomach with jejunal patch in lesser curvature. Chronic ulcer in patch and chronic ulcer at usual site in jejunum thirty days after surgical duodenal drainage (Group 6).

mal dogs. Exploratory laparotomy was performed at various intervals from twenty to sixty-five days afterwards. A typical subacute or chronic peptic ulcer was found at the usual site in the jejunum of every dog. At the same laparotomy gastro-enteric anastomosis was made. In each experiment a loop of jejunum about 20 to 40 cm. distal to that containing the ulcer was anastomosed to the stomach anteriorly and in the isoperistaltic direction. The stoma was made large enough for the greater part of the gastric contents to empty through it (Table IV).

At various intervals, from four to sixteen days, after gastro-enterostomy necropsy was performed. In every case the ulcer showed unmistakable signs of healing. In two experiments small but typical subacute ulcers had healed entirely in ten and fifteen days, respectively, after gastro-enterostomy. In

another experiment a typical, indurated, chronic ulcer measuring at exploration 1 cm. in diameter and 0.5 cm. in depth had healed almost completely in sixteen days (Fig. 8). The rate of healing of the ulcers after gastro-enterostomy was in direct proportion to the size and chronicity of the ulcer and the duration of the gastro-enteric anastomosis. Microscopically the healing was very similar to that previously described by Mann and alluded to in this paper, although it was not as rapid and clean and orderly as the healing he induced by gastro-enterostomy and pyloric exclusion which completely protected the ulcer from contact with acid chyme (Figs. 9 and 10).

Besides the healing ulcers found at necropsy new, developing ulcers were usually found in the efferent loop of jejunum just opposite the gastro-enteric

Table 4 Synopsis of the protocols of the nine experiments with healing ulcer

Experiment	Surgical duodenal drainage Date, 1926	Exploration and gastro-enterostomy			Necropsy		
		Date 1926	Interval, days	Findings and remarks	Date 1926	Interval, days	Findings and remarks
1	4-25	6-3	38	Chronic ulcer 1 cm. in diameter. (No gastro-enterostomy)			
		6-17	52	Chronic ulcer 2 by 1.5 cm. 1 cm. in depth	7-2	15	Marked healing. Induration has subsided. Ulcer only 1 by 1.8 cm. in diameter and 0.3 cm. in depth.
2	6-25	7-15	20	Two subacute ulcers, each 0.5 cm. in diameter and about 0.4 cm. in depth	7-30	15	Both ulcers entirely healed. Difficult to find scars.
3	6-25	7-15	20	Two subacute ulcers, one 0.3 cm. in diameter and 0.3 cm. in depth, the other 0.6 cm. in diameter and 0.2 cm. in depth	7-24	9	Both ulcers entirely healed. Difficult to find scars.
4	7-5	9-8	65	Chronic ulcer 1 cm. in diameter and 0.5 cm. in depth	9-18	10	Marked healing. Induration has subsided. Ulcer now 0.6 cm. in diameter and 0.1 cm. in depth
5	7-19	9-8	51	Subacute ulcer 1.5 cm. in diameter and 0.2 cm. in depth	9-15	7	Definite healing. Induration has subsided. Size unchanged
6	7-19	9-9	52	Chronic ulcer 1.5 cm. in diameter and 0.7 cm. in depth	9-19	10	Definite healing. Induration has subsided. Diameter of ulcer unchanged, depth now 0.2 cm.
7	7-19	9-9	52	Chronic ulcer 1 cm. in diameter and 0.5 cm. in depth	9-25	16	Marked healing, almost complete. Superficial scar-like area 0.4 cm. in diameter remains.
8	7-22	9-10	50	Chronic ulcer 1.5 cm. in diameter and 0.5 cm. in depth	9-14	4	Definite healing, induration has subsided. Diameter of ulcer unchanged, depth now 0.2 cm.
9	7-29	9-13	46	Chronic ulcer 1.5 cm. in diameter and 0.7 cm. in depth	9-20	7	Marked healing. Induration has subsided. Ulcer now 0.7 by 0.8 cm. and 0.1 cm. in depth

stoma. These ulcers were found always at the point in the efferent loop against which the acid chyme emptying from the stomach impinged most directly.

GROUP 9.—*Ulcers in the Duodenum Following Certain Miscellaneous Procedures.*—In a small number of dogs surgical duodenal drainage was established by a slightly modified technic. Instead of the jejunum being anastomosed end-to-end with the pylorus, the pyloric third of the stomach was resected and the jejunum was anastomosed to the stump of the stomach by the method of Billroth in some cases and by the method of Polya in others. The area of the stomach was thereby decreased and the amount of acid secreted thus probably diminished. The duodenum was anastomosed to the ileum as usual. Even following such modified forms of surgical duodenal drainage, ulcers were usually found in the jejunum at the point where the acid chyme emptying from the stomach impinged directly against

the wall of the intestine. The ulcers, however, were not so typically chronic as those following the ordinary type of surgical duodenal drainage and were oftener subacute or acute.

In a rather high percentage of dogs following ligation of the common bile duct, ulcers were found in the duodenum just distal to the pylorus where the emptying acid chyme from the stomach impinged against the wall of the intestine. The ulcers found in such experiments were oftener subacute than chronic, although occasionally deep indurated lesions were found. Ligation

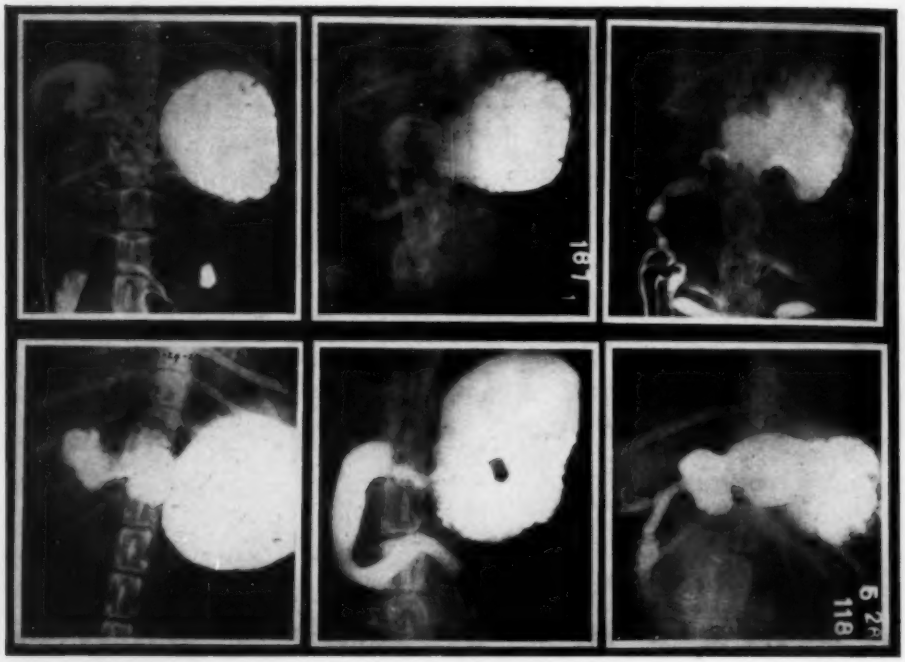

FIG. 7.—Ulcers of the jejunum following surgical duodenal drainage in Group 7. a. Normal before operation. b. Ulcer crater. c. Larger ulcer crater. In another experiment: d. Normal before operation. e. Normal after operation. f. Ulcer crater found at later examination.

of the common duct of course induced deep jaundice, but ligation also excluded bile from the duodenum and other parts of the gastro-intestinal tract.

GROUP 10.—*Miscellaneous Methods by Which Healing of Peptic Ulcers Was Induced.*—A few experiments were performed similar to those of Mann, who induced healing of ulcers following surgical duodenal drainage by gastro-enterostomy and pyloric exclusion. Ulcers were thereby entirely protected from acid chyme and healed quite rapidly as described by Mann. Ulcers developed in the efferent loops of the gastro-enteric anastomoses just as they had in previous experiments. They formed more rapidly in this group than in Group 8 in which the pylorus was not excluded.

In a few experiments typical chronic ulcers at the usual site following surgical duodenal drainage were healed by duodenojejunostomy. The anas-

tomosis was made between the closed upper part of the duodenum and the jejunum, and the stoma was situated opposite the ulcer. Alkali was thereby drained into the jejunum at the site of the ulcer. In all these experiments the ulcer showed definite characteristics of healing.

Healing was induced in a few typical chronic ulcers by gastroduodenostomy. The closed upper part of the duodenum was anastomosed to the pyloric region of the stomach (Fig. 11). By this method also alkali was presumably drained into the stomach. Moreover, drainage of some of the

FIG. 8.—Healing ulcer sixteen days after gastro-enterostomy and new ulcer developing in the efferent loop (Group 8).

acid chyme from the stomach probably took place through the duodenum and thence into the ileum. Healing that followed this procedure was quite rapid and satisfactory.

Discussion.—Acute lesions in the normal stomach and duodenum of experimental animals and man usually heal with great rapidity and completeness. This was verified by the experiments in the first group; areas in the stomach and duodenum were denuded of mucosa, and in some cases of both mucosa and muscularis, and yet they healed in two weeks. Healing on the lesser curvature, however, was a trifle slower than that in other parts of the stomach.

The results of the experiments in the second group were striking in that peptic ulcers developed in the jejunum in 100 per cent. of experiments following surgical duodenal drainage. The ulcers were typical subacute and chronic lesions and were grossly and microscopically almost indistinguishable from peptic ulcers found in the duodenum of man. They occurred just distal

to the pylorus at the point where the acid chyme emptying from the stomach impinged directly against the wall of the intestine. This site corresponds to that at which duodenal ulcers are found in man. They occurred in the jejunum which had been so transplanted that anatomically it took the place of the duodenum. All the alkaline duodenal secretion and alkaline bile and pancreatic juices normally present in the duodenum at the pylorus and regurgitating into the stomach had been drained into the ileum at such a distance that their regurgitation as far as the stomach (or intestine into which it emptied) was precluded. The stomach ejected its acid through its nozzle-like

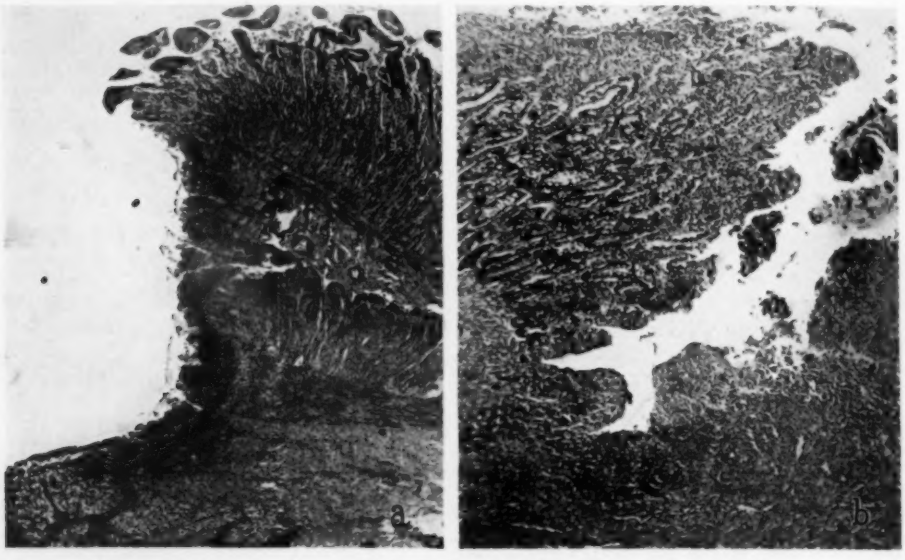

FIG. 9.—a. Typical eroding margin of a chronic ulcer (x 25) (Group 2). b. Typical healing margin of the same original type of ulcer four days after gastro-enterostomy (x 60) (Group 8).

pylorus (Mann) into the transplanted jejunum, a portion of intestine containing no appreciable amount of alkali. Typical chronic peptic ulcers formed at the point where the acid ejection from the stomach impinged against the wall of the jejunum.

That the ulcers occurred in the jejunum is not important in itself. This is proved by the original experiments of Mann and Williamson, for they produced ulcers in the duodenum itself in a high percentage of experiments in which they transplanted the bile duct and pancreatic ducts into the lower ileum and left the duodenum in its normal relation with the stomach. Both procedures accomplish the same result, namely, drāining the alkali away from the stomach and the intestine into which it empties. The technic of surgical duodenal drainage employed in these experiments was adopted because it was simpler than transplantation of the ducts and still accomplished the same result. The occurrence of ulcer following surgical duodenal drainage seems justly attributable to the absence of alkaline bile and pancreatic juices in the region, and the site of the ulcer seems to be explained by the way in

which the acid ejection impinges directly against a relatively circumscribed area of the intestinal wall.

In the third and fourth groups, areas in the stomach denuded of mucosa, which under normal conditions would have healed rapidly, did not heal well when subjected to the altered conditions set up by surgical duodenal drainage. Delay in healing was most marked on the lesser curvature and in more than 50 per cent. of experiments typical chronic ulcers formed in the areas on the lesser curvature at the same time as similar areas in the same stomach on the greater curvature were healing, either partly or completely. These ulcers were grossly and microscopically almost indistinguishable from gastric ulcers found in man and their site was also the same as that of the greater percentage of clinical gastric ulcers, namely, the lesser curvature.

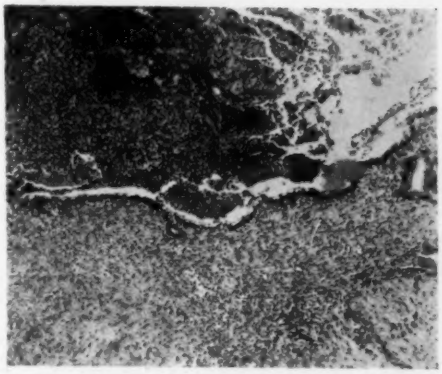

FIG. 10.—Growing edge of mucosa in a healing jejunal ulcer seven days after gastro-enterostomy (x 60) (Group 8).

The lesser curvature has certain anatomic and physiologic peculiarities. Its mucosa is closely attached and relatively smooth, so that it may not readily protect itself by folding and forming the rugæ that are so abundant in the fundus. The lesser curvature is the "Magenstrasse," the gastric street, as it is called by Aschoff and others. The contents of the stomach are impelled against the lesser curvature and propelled along its surface by the force of the muscular contractions of the emptying stomach. When the lines of force exerted by the contraction of the stomach are mapped out, it is apparent that they tend to converge along the lesser curvature.

The gastric ulcers in these experiments formed after the establishment of surgical duodenal drainage, which drained the alkaline bile and pancreatic juices away from the pylorus where they are normally present and precluded the possibility of their regurgitation into the stomach. The ulcers were found on the lesser curvature, the part of the stomach which bears the brunt of the trauma resulting from the process of emptying the acid chyme from the stomach.

In the experiments with jejunal patches in the stomach strikingly similar results were obtained. Patches, with one exception, transplanted into various situations in the normal stomach remained unchanged for long periods. The exception was an ulcer that formed on a patch in the lesser curvature. Patches were then subjected to the altered conditions induced by surgical duodenal drainage. Except for a superficial erosion on a patch in the anterior wall of the stomach, patches in all sites except the lesser curvature remained normal. In three of five experiments typical subacute and chronic ulcers developed on patches in the lesser curvature. Patches of jejunum have been transplanted to an unaccustomed acid environment. This they withstood

fairly successfully in the normal stomach, although one ulcer did form on a patch in the lesser curvature. Even following surgical duodenal drainage, they withstood the still more inimical environment fairly well except on the lesser curvature. Ulcers formed on three of five patches in this region. The patches may well have served as points of least resistance in the stomach.

In the seventh group of experiments the formation of ulcers in the jejunum following surgical duodenal drainage was followed röntgenologically. Ulcers were depicted well in the examinations, but no abnormalities in con-

FIG. 11.—Healing ulcer after gastro-duodenostomy (Group 10).

traction or emptying of the stomach were detected as bearing a causal relationship to the ulcer.

In the eighth group of experiments, healing of ulcers induced by surgical duodenal drainage followed simple gastro-enterostomy. In all cases the gastro-enteric stoma was made large so as to drain the greater part of the gastric contents through it. The stoma was made in a loop of jejunum only a short distance from that containing the ulcer and too far away from the point of duodenal anastomosis with the ileum for regurgitation of alkali as far as the gastro-enteric stoma to occur. The gastro-enteric stoma apparently drained most of the acid chyme from the stomach and, by decreasing the amount of acid chyme ejected through the pylorus and the force with which it was ejected against the original ulcer, relieved the strain upon the ulcer and allowed it to heal. This explanation seems to be substantiated by the formation of the new ulcer at the gastro-enteric anastomosis. The new ulcer formed in the efferent loop opposite the stoma at the point where the acid chyme emptying through the gastro-enteric stoma impinged directly against the wall of the intestine.

In the experiments of the ninth group, ulcers in the jejunum occurred in a few experiments in which surgical duodenal drainage was established after a part of the stomach had been resected. Alkali had been excluded from the field, as in the ordinary type of surgical duodenal drainage. Ulcers did not form as often as before and those found were not chronic. The lesions were more like erosions than chronic peptic ulcers. Other experiments were cited in which ulcers were found after ligation of the common bile duct. Jaundice followed and possibly other upsets occurred, but probably the most important change locally in the duodenum was the exclusion of the alkaline bile from its lumen. Ulcers were found but here again they were not chronic. The alkaline bile had been excluded but the alkaline duodenal secretion and pancreatic juices were still present.

In the last group of experiments three methods of inducing healing of chronic ulcers were cited. Gastro-enterostomy with exclusion of the pylorus induced healing by completely protecting the ulcer from the acid chyme. This method was originally employed by Mann. Healing was also induced by operations in which the alkali in the duodenum was drained back again into the area of the chronic ulcer. In such experiments the acid chyme was still ejected against the ulcer, but nevertheless the introduction of alkali into the area was followed by healing. In the eighth group, healing of the ulcer occurred after gastro-enterostomy which did not introduce alkali into the field of the ulcer but did lessen the amount and the force of the ejections of acid chyme against the ulcer.

In all the experiments, the formation of chronic peptic ulcers of the stomach, duodenum and jejunum followed the withdrawal of alkali from the stomach and intestine into which it emptied, and the site of the ulcer in each case was determined by the point at which the forces of acid ejections converged. Healing of the ulcers ensued when measures were taken to re-introduce alkali into the region of the ulcer or when the forces of the acid ejections of the stomach were diffused or counteracted. The recognition of these factors may prove to be of some value in the etiologic and therapeutic consideration of clinical peptic ulcer.

SUMMARY

Some of the literature on experimental peptic ulcer has been briefly summarized and the characteristics of acute and chronic and healing peptic ulcers described. Ten groups of experiments have been studied.

The inherent power of the normal stomach and duodenum to heal was verified. In a group of twenty experiments, subacute and chronic ulcers occurred in the intestine just distal to the pylorus in 100 per cent. of experiments following surgical duodenal drainage. It was found that surgical duodenal drainage retarded the healing of denuded areas in the stomach, especially on the lesser curvature. In the experiments of this nature typical subacute and chronic ulcers formed on the lesser curvature in as high as 62.5 per cent. of experiments. Large numbers of patches of jejunum of whole

thickness and with intact mesenteric circulation when transplanted into various regions in the walls of the stomach remained normal, except for one experiment in which an ulcer formed on a patch in the lesser curvature of the stomach. Patches that had remained normal for long periods were then subjected to the altered conditions following surgical duodenal drainage. Except for a superficial erosion on a patch in the anterior wall no ulcers formed on patches in other situations than the lesser curvature. In three of five experiments chronic ulcers formed on patches in the lesser curvature.

Röntgenologic studies were made of chronic ulcers induced by surgical duodenal drainage. Ulcers were well depicted by fluoroscopic and röntgenographic examinations, but no disturbance in the motor mechanism of the stomach could be detected as having a causal relationship to the formation of ulcer.

In a group of chronic ulcers following surgical duodenal drainage, healing was induced by gastro-enterostomy. The formation of new ulcers in the efferent loop demonstrated that the large gastro-enteric stoma had assumed the greater part of the load of draining the acid chyme from the stomach. The original ulcers, being thereby proportionally relieved of irritation, healed.

In a few experiments ulcers followed certain other procedures which decreased the amount of alkali present in the duodenum. In experiments of the last group healing of chronic ulcers followed the re-introduction of alkali into the region of the ulcer.

In the author's experiments the formation of chronic peptic ulcers of the stomach, duodenum and jejunum followed the withdrawal of alkali from the stomach, and intestine into which it emptied, and the site of the ulcer in each case was determined by the point at which the forces of acid ejections converged. Healing of the ulcers ensued when measures were taken to re-introduce alkali into the region of the ulcer or when the forces of the acid ejections of the stomach were diffused or counteracted. The probable bearing of the recognition of these factors in the etiology and treatment of clinical peptic ulcer was mentioned.

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TREATMENT OF ACUTE CHOLECYSTITIS *

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Acute cholecystitis may be compared to acute salpingitis in that it rarely kills if treated conservatively. Surgical writers are prone to compare it to acute appendicitis, but this comparison is not in consonance with the clinical facts. Acute appendicitis is a lethal disease because it so frequently results in diffuse peritonitis. Acute cholecystitis does not cause widespread peritonitis unless a perforation occurs early in the attack and the contents of the gall-bladder are spilled into the free peritoneal cavity, fortunately such a perforation is a rare event. When the gall-bladder is acutely inflamed it is very quickly walled off—the liver, omentum, parietal peritoneum and transverse colon form a barrier against the spread of infection. W. J. Mayo [1] speaks of this protective process and also states that the escape of septic material from the gall-bladder and bile-ducts has a tendency to set up a rather mild form of peritonitis. Deaver and Burden [2] attribute the rarity of acute perforation to both the protection of surrounding structures and to the fact that the bile tension in the gall-bladder is never high.

Occasionally cholecystitis requires surgical treatment during the acute attack, but it is my conviction that as a rule the operation should be avoided until the signs of active inflammation have disappeared. However, the patient belongs in a hospital under the observation of a surgeon. Rest, morphine, ice packs and the administration of large quantities of water and glucose suffice, in almost every instance, to limit the inflammatory process. The specific action of glucose in combating the effects of damage to the liver has been emphasized again by the work of Mann and Magath.[3] In the severer gall-bladder infections glucose should be given intravenously. Operation is indicated in any case when the diagnosis is questionable or if a perforation is suspected. The gravest danger in this conservative treatment is the possibility of a mistaken diagnosis; I have seen acute appendicitis, mechanical ileus and a perforated ulcer diagnosed as cholecystitis and abstention from operation practiced. I have lost patients who were operated upon in the acute stage of cholecystitis and I now believe that these patients might have lived had operation been postponed. Wilkie [4] has shown that acute inflammation of the gall-bladder is frequently associated with signs of infection at the base of the right lung, and in my experience pneumonia is one of the chief causes of death after operations performed during the acute attack. I have had one death from acute perforation of the gall-bladder, this perforation was recognized early, but permission to operate was refused. I am advising a conservative course in all types of acute inflammation of the gall-bladder if I believe that the disease is limited to the organ and its immediate neighborhood. As a matter of fact, no finite mind can distinguish

* Read before the Western Surgical Association, December 9, 1927.

between most cases of acute catarrhal inflammation and an empyema. When I am impelled to operate during the acute stage the gall-bladder is usually so damaged that I perform a cholecystectomy. I admit that my preoperative intentions are usually to do a simple drainage operation, but I have not found a cholecystostomy to be an easy procedure in these cases.

The literature of no other abdominal, inflammatory condition presents so wide a difference of opinion, among surgeons of experience, as to the indications for operation. And among those who advocate immediate intervention there is a marked divergence of views as to the operation of choice.

In an English text-book we find Walton [5] comparing cholecystitis to appendicitis and insisting upon immediate cholecystectomy. He claims that if the operation is performed within twenty-four hours of the onset that it is as free from danger as the corresponding one performed for appendicitis. Bland-Sutton [6] asserts that to operate for acute cholecystitis and not remove the gall-bladder is as reprehensible as operating for gangrenous appendicitis and leaving the appendix. A "Leading Article" [7] in the British Medical Journal commented on this assertion and stated that "the practice of this operation (cholecystectomy) is admittedly no less beneficent in the acute forms of gall-bladder disease than when the infection is of slight intensity," but a warning is given of the danger of irreparable harm from injury to the ducts or vessels. Symonds [8] vigorously refuted these statements claiming that they are not based on correct pathology and are inconsistent with clinical experience and he concluded that urgent operation is never called for. Moynihan [9] waits when possible until the interval and then removes the gall-bladder. Wilkie [10] is of the same mind, but in patients over sixty years of age, if the symptoms do not show evidence of subsiding within thirty-six hours of the onset of the attack, he operates and drains the gall-bladder. In younger subjects if the acute symptoms do not subside after a few days and when there is an empyema of the gall-bladder, he operates and, as a rule, does a cholecystectomy.

In France the Lyons school, led by Leriche and Cotte, insist that this disease should be treated by an immediate cholecystectomy. The subject was discussed at two sessions of the Lyons Surgical Society [11] in 1923. It appears from this discussion that the conduct which then prevailed in France was to practice a minimum of intervention during the acute attack, in an emergency a cholecystostomy was performed to be followed by a secondary cholecystectomy. At one of these sessions Chalier [12] reported two cases of acute cholecystitis, one grave and the other serious, treated by immediate cholecystectomy and closure of the abdomen without drainage. It is notable that the advisability of this procedure was not questioned. A critical review of the more recent French literature convinces me that Soupault and Thalheimer [13] are correct in stating that the present tendencies in France are in favor of an intervention without delay in the course of a serious attack of acute cholecystitis. In fact, I have not been able to find a French surgeon who is now advocating abstention from operation; however, the nature of the

intervention is still the subject of active discussion. Lecéne [14] now recognizes that cholecystectomy has undeniable advantages in acute cholecystitis, but as it may be dangerous, in many of these cases he is content to practice a cholecystostomy under local anæsthesia. Pauchet [15] recently recommended drainage in the acute stage to be followed, after the infection has disappeared, by the removal of the organ. This is also the opinion of Mocquot,[16] but Berger [17] appears to believe that the second operation is unnecessary. Cuneo [18] has taken the position, which seems to be fairly common among French surgeons, that if the whole gall-bladder wall is involved in the inflammatory process (pancholecystitis of Lecéne) that drainage alone is not enough to stay the progress of the acute disease. Gaudin [19] is impressed by the results of immediate cholecystectomy and believes that the subserous removal during the acute stage presents no notable difficulties for any operator, however lacking in experience he may be. Savariaud [20] believes that both operations have their indications but he also practices cholecystenterostomy in certain cases.

Most German surgeons, if we can believe their most recent system of surgery (Heller [21]), postpone operation until the interval and they feel that operation is only indicated by progressive phenomena. In March, 1927, Dührssen [22] stated that this is the practice at the Berlin Charite where operation is performed eight days after the disappearance of the last acute symptoms; perforation, icterus with grave infection and involvement of the peritoneum being the absolute indications for interference during the attack. Interest in this question was stimulated by the conservative papers of Enderlen [23] and Hotz which were presented at the 1923 meeting of the German Surgical Association. Hotz demonstrated that, in the cases reviewed, the mortality of operation performed during the attack was double that of operation performed during the remission. In 1924, the Medizinische Klinik [24] published the results of a questionnaire, covering this subject, which had been submitted to the leaders of German Surgery. A careful reading of the replies convinces me that most of these men are not as conservative as the above statement would indicate. While the majority of them prefer postponing operation until the acute stage has passed, practically all of them operate if the symptoms are unusually severe or if an empyema is suspected. This appears to be the position of Enderlen, Küttner, Kappis, Schmieden, Perthes, Anschuetz, Laewen [24] and Koerte.[25] Operation with them is almost a synonym for cholecystectomy. Kirschner [26] is the chief German protagonist of early cholecystectomy. He believes that the operation is easier to perform during the stage of active inflammation and he advances the naïve reason that the patient is more willing to submit to operation during the acute attack. Kirschner does not urge operation within the first hours after the patient is admitted to the hospital, but usually takes one day for pre-operative preparation. Stich [24] holds that operation is justifiable only in the first twenty-four or forty-eight hours of the acute seizure.

American surgeons are likewise diverse in their views on this subject.

Haggard [27] states that the rarity with which patients ever die from an acute cholecystitis when left alone should compel us to avoid operation in the acute stages, which is notoriously dangerous. McGuire [28] laments the fact that there is no general rule to guide us in these cases, unless the cholecystitis is attended by symptoms which cause alarm he is in favor of waiting until the acuteness of the infection subsides. Two authors discuss this topic in the same number of a surgical periodical. Deaver,[2] in one article, writes that when possible operation should be deferred until the subsidence of the acute attack, but if interference is demanded the acutely inflamed gangrenous or perforated gall-bladder should be removed whenever possible. Cave,[29] the other essayist, advises waiting to see if there is a "cooling off," but if after thirty-six or forty-eight hours the symptoms do not improve, a cholecystostomy is indicated, and he warns of the grave danger of removing "the especially acutely inflamed partially gangrenous or ruptured gall-bladders." Bunts [30] remarks that no operation should be performed in the case of an acute attack unless empyema is suggested; when the patient's condition is grave a cholecystostomy should be done. Lyons and Judd [31] write, in 1923, if the condition is acute it is better to wait until the attack subsides before operation. W. J. Mayo [32] recently described a method of performing cholecystectomy in acute cholecystitis. In 1925 there were fifty-four operations at the Mayo Clinic [33] for acute cholecystitis, fifty-one were cholecystectomies and three were cholecystostomies. Behrend [34] teaches that one should not operate for empyema of the gall-bladder until the temperature has been normal for several days and the gall-bladder is freely palpable without pain. Muller [35] does not approve of immediate operation in acute empyema, ordinarily he delays operation until the temperature reaction and pulse rate are falling and the symptoms of rigidity and tenderness become localized in the gall-bladder region. It is the general practice at the Massachusetts General, according to Richardson,[36] to let the attack quiet down and the patient recover his balance before operating unless some feature of the cases makes it particularly urgent. Lewis [37] informs me that about the same practice obtains at the Johns Hopkins Hospital and he feels that in most instances the urgent cases should be drained. Archibald [38] writes that at the Royal Victoria Hospital they usually prefer to wait, unless threatening symptoms are present suggesting gangrene, that is unusually rapid pulse and prostration and then they do nothing more than a simple drainage. Archibald remarks: "I consider cholecystectomy in acute cholecystitis as unwarranted danger." Crile [39] does not like to operate during the acute attack, but inasmuch as it is rather difficult to foresee whether or not a rupture may occur, he generally operates and drains the gall-bladder. "In going over our gall-bladder statistics here," he writes, "we have been rather impressed by the large percentage of cures following a cholecystostomy in these cases." McArthur [40] is of the opinion that operation may be delayed for a few days if the pulse temperature and subjective symptoms permit. He believes that if the patient is in good condition, a cholecystectomy should be done; if in desperate con-

dition, with toxæmia and gangrene, drainage is advisable. Coffee [41] has no general or set rule letting each case be governed by itself.

In conclusion I wish to express the hope that some day surgeons will be fairly unanimous in their views on the treatment of acute inflammations of the gall-bladder. It is obvious that we can follow whatever plan of treatment we may choose in the mild attacks of the disease and it will make but little difference in the outcome. Certainly, it is only in severe cases that the question of operation becomes of major importance. At present I feel that I have ample support in my position that operation is very rarely indicated.

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POINTS IN THE TECHNIC OF OPERATIVE REMOVAL OF KIDNEY STONES*

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In the course of many years of work in the removal of kidney stones, in which many hundreds of cases have been operated upon, I have been able to gradually work out a more and more satisfactory technic. The object of the kidney stone operation is, to remove all calculous material and at the same time to spare the kidney as much as possible, so that its functional parenchyma is damaged not at all or but slightly.

Fig. 1.—Unilateral renal lithiasis illustrating types of stone removed by pyelolithotomy, with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

Before approaching the operative treatment of kidney stones, the surgeon must know whether the patient's kidney is infected or not; whether it is sufficiently preserved to be a usefully functioning organ, and is worth saving; whether the other kidney is able to carry on, should a nephrectomy be necessary. Also, whether the involved kidney is the only kidney that the patient possesses. All these factors are of great importance, and must be borne in mind by the operator. For instance, if a kidney is infected and the stone is removed by nephrotomy, sutures passed through such a nephrotomized kidney may lead to secondary diffuse kidney-infection, so that the kidney must be subsequently sacrificed. Moreover, if the stone is in a solitary kidney, such kidneys should be handled very gingerly and not dislocated from their normal positions, the operation being done *in situ*. Then, too, if the functional tests show that the organ is practically negligible and full of pus, unless one finds adequate parenchyma at operation it may be advisable to remove the kidney and the stone together.

* Read at the Academy of Medicine, December 21, 1927.

In looking over a series involving 271 stone cases between the years of 1921 and 1925, I find that in 18 per cent. the kidneys were so badly destroyed that it was inadvisable to save the organ. In 5 per cent. of the cases, owing to the fact that the other kidney was badly diseased or that the stone was in a solitary kidney, the stones were removed without dislocating the organ. In all the other cases, the operation of choice was pyelotomy or nephrotomy, or the two operations combined. Of late, pyelotomy is becoming more and more popular on my service, even though it is frequently associated with a small nephrotomy incision, which may be used not only for extracting small calculi in the calyx, but also for drainage of the kidney pelvis. In reviewing my personal very recent records, in 38 kidney stone cases there were 23 pyelolithotomies, 6 pyelolithotomies combined with nephrotomies, one nephrolithotomy and 8 nephrectomies. This very definite swing toward pyelotomy for all cases is entirely due to our X-ray control of the exposed kidney on the operating table, which makes for complete removal of all stone material. Moreover, the operative approach through the pelvis meets the other desideratum mentioned above—it spares kidney parenchyma.

FIG. 2.—Unilateral renal lithiasis illustrating types of stones removed by pyelolithotomy, with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

To carry out these two principles—to remove all the calculous material and to spare as much kidney parenchyma as possible—it is necessary to make an adequate exposure, a real surgical exposure of the kidney, which I find is best done through an inverted "S" incision in the lumbar region, beginning close to the eleventh rib at the margin of the erector muscle and passing obliquely down through the lumbar space between the crest of the ilium and the last rib. Paralleling the last rib, it should extend forward and downward in front of the anterior spine as far as is necessary to get an adequate approach. The kidney being exposed through this incision, is gradually liberated from its perinephric fat; adhesions to the upper pole should be carefully ligated before being cut, and then the kidney can usually be completely liberated and dislocated unless there are contra-indications to this procedure. This usually permits the operator to raise the organ well up to the muscular or skin plane. Having exposed the kidney in this way, the ureter should regularly be exposed and a double loop of heavy catgut should

be thrown around the ureter to constrict its lumen, which prevents fragments which may break off from the stone or stones slipping into the ureter and subsequently causing obstruction or symptoms due to the existence of fragments in either the lumbar or the pelvic ureter.

With the kidney well exposed, the great majority of stones can be removed, often without fragmentation, by a posterior pyelotomy incision, which if necessary can be prolonged (usually without striking any sizable vessels) well into the adjacent parenchyma. If an abnormal vessel interferes with this approach, it can usually be pushed aside, and only rarely has to be ligated. Occasionally it may be simpler to make an inferior pyelotomy approach, dislocating the lower pole cephalad and incising the pelvis on this surface. Much more rarely is one compelled to do an anterior pyelotomy, pushing the vessels out of the way, or even without dislocating the vessels.

The removal of the stone or stones through the pyelotomy incision, though often very simple, at times may be most difficult. For instance, in a very stout patient with a small movable stone, after dislocating the kidney one may not be able to recognize the site of the stone, even though in the X-ray picture it seemed to be in the pelvis. In such cases, the stone having escaped into a more or less dilated calyx, it is often easier to replace the kidney and follow up the ureter to the pelvis and do a pyelotomy *in situ*, allowing the finger or a stone curette or forceps to locate the stone, and then extracting it. In other cases, the numerous stones scattered throughout the calices may be difficult to remove, as the neck of a calyx which harbors stones may be stenosed and one can not feel with one's fingers the calculi retained in such a calyx. With an X-ray film of the exposed kidney taken then and there (to which I expect to refer later), the location of these stones can readily be ascertained and they can be removed with ease through a small nephrotomy incision. There are other cases in which the stone is pyramidal in shape, with the base of the pyramid in the calyx and the apex extending into the pelvis, where it may be united with a well-formed pelvic stone. To try to deliver the base of such a stone through a narrow caliceal neck is liable to damage the adjacent kidney tissue. And in these cases again it is wise to make a small nephrotomy incision and deliver the stone through this incision.

All in all, it is surprising how readily one can deliver through a large pyelotomy kidney stones of the most remarkable and distorted shapes by gently twisting and rocking the stone as the kidney is firmly held. And these forceps deliveries, if gently carried out, can often be done without any damage to the stone, without any fragmentation, and without any real injury to the kidney itself. Fragmentation, which used to be dreaded because of the danger of leaving pieces of stone in the kidney, occasions no such feelings since X-ray control is available.

After I have cleared out such a kidney by the above manœuvres, I regularly wash out the organ with a strong stream of water introduced through a large catheter, so as to clean out any sand or fragments from the pelvis or calyces. To avoid wetting the patient as well as the operator during this

irrigation, a suction tube is placed in the wound, which takes up the water as rapidly as it runs out alongside the catheter, either from the nephrotomy or the pyelotomy incision. Having apparently removed all the stones and all the fragments, during the last three or four years I at first controlled the completeness of my operation by fluoroscoping the kidney. (Brewer, Braasch.) This has not proven very certain and reliable, and repeatedly small stones—even one to two dozens—have been removed from the kidney directly after the fluoroscopic examination had shown that the kidney harbored no more calculi. Since Quinby had such excellent results with films, I have given up fluoroscopy and taken pictures for immediate development close to the operating room of all cases of this type. And though up to date I have had not more than 24 to 30 of such controls † on the operating table, the value of this coöperation with the X-ray department is so great that no patient with a complicated stone in his kidney is taken to the operating room for its removal without making sure that such X-ray control is available and ready. Naturally, in patients with single small stones in the pelvis of the kidney, or even in the calyx, we do not insist upon such X-ray control. Nevertheless, during recent years probably 30 cases fell into the category of those that should be controlled on the operating table and frequently when the operator had the impression that all stones were removed, the X-ray film proved him to be incorrect and located one or more stones in some part of the kidney, which the operator had not been able to detect. These stones were then almost regularly removed by a nephrotomy into a closed calyx, or by reëxploration of the pelvis proper.

FIG. 3.—Bilateral renal lithiasis illustrating types of stone removed by pyelolithotomy with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

The importance of this control cannot be exaggerated, as any fragments left behind make for an incomplete operation. And moreover, there is nothing more disheartening to a surgeon than to have operated, for instance,

† Four more cases have been thus controlled in the last month.

for three or four stones which are definitely present in the X-ray, and at the end of the operation have only one such stone to show his patient. Years ago, before we had this valuable adjunct, whenever I was in this predicament and had not recovered all the stones I made a stab nephrotomy, hoping that what was overlooked might come out through or alongside the tube following subsequent irrigations. In one case where I was particularly chagrined to find only one stone when four small stones had been shown in the X-ray, the three other stones were recovered in this way. However, this good luck does not always follow a nephrotomy, and X-ray control has done away with this haphazard method of looking after our failures.

FIG. 4.—Bilateral renal lithiasis illustrating types of stone removed by pyelolithotomy, with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

If the pyelotomy approach is impossible, due to the adhesions about the pelvis and short pedicle, or due to the distribution of the stones in the parenchyma, it may be necessary to do a primary nephrolithotomy to reach the calculi scattered through the kidney. For these wide nephrotomies, as opposed to the small nephrotomies associated with pyelolithotomy, it is well to control the bleeding from the kidney parenchyma, lest the patient, in the course of the operation, lose an excessive amount of blood, as is so frequently observed in most operating rooms where nephrolithotomies or exploratory nephrotomies are performed. To avoid loss of blood—in other words, to do the operation under almost complete ischæmia—I have thrown a soft rubber tube about the kidney pedicle, crossing the two loops of the rubber tube on the anterior surface of the pedicle, and at the crossing placing an artery forceps. This constriction of the pedicle prevents loss of blood from the kidney, and one can incise far and wide, making a complete exploration, even from pole to pole, without any risk of hemorrhage on the operating table. In one such case I found scattered through the pelvis and calyces over fifty bizarre-shaped oxalate stones, many of them looking like jackstones, which

could not possibly be delivered from the pelvis, as it was impossible to deliver the organ adequately.

Having removed the stones from these cases by wide nephrotomy, an X-ray film can readily be taken, even though the organ cannot be well dislocated. However, one may have difficulty in getting a complete picture due to the fact that it is hard to introduce a film well into the patient's body and so cover the whole kidney. It should be noted that in taking these exposures, a marker (either a needle, or an artery forceps, or both) should be placed upon or in the kidney, to mark the upper or lower pole and to give the operator some idea of the relative distance any overlooked stones may be from the marker.

FIG. 5.—Bilateral renal lithiasis illustrating types of stone removed by pyelolithotomy, with X-ray control of exposed kidney in operating room, complete removal being obtained in this way.

Many of these kidneys which have been the site of stones are liable to be adherent to the perinephric fat, and as one attempts to deliver them the capsule of the kidney is stripped back, which, if one finally succeeds in delivering the kidney, compels the operator, if he attempts to do a pyelotomy, to first cut through the reflected capsule, then the adherent perinephric fat, and then the fat surrounding the pelvis of the kidney, and finally the pelvis itself, before reaching the stone. This complicated situation, however, is readily met if one bears in mind the pathological and the anatomical conditions created by stripping back the capsule.

After doing a nephrotomy in this way, the open vessels on the cut surface can readily be tied by passing a suture on a fine needle armed with catgut around the exposed vessel twice, and then tying it. It is always wise to use as few sutures as possible in closing the nephrotomy incision, both to avoid infecting the parenchyma, as most of these kidneys harboring stones are liable to be mildly infected, as well as to avoid strangling too much of the kidney parenchyma, which may convert what was a fairly useful organ into a functionally poor one. If the capsule is still adherent, it may be possible to make use of the resistance that it offers and apply mattress sutures of

chromic gut to close the incision, taking a few sutures well in from the convexity and a few more nearer the convexity. If, however, the capsule has been stripped back, no such support is present to prevent sutures cutting into the parenchyma; and in these cases it is important to underpin sutures as described by me ‡ some years ago, either with fat, fascia or muscle, which absolutely prevents any cutting into the parenchyma when the sutures are tied. It seems to me that these double chromic gut sutures underpinned with fat, etc., strangle less tissue than the mattress sutures; and even in those kidneys with capsules attached, I am inclined to use this type of underpinned suture, rather than the mattress suture.

After one is satisfied that all fragments are recovered, and after one has sutured the kidney incision, the rubber ligature on the vascular pedicle is loosened, and the replaced kidney is compressed *in situ* with gauze for a few moments, to be sure that no active bleeding is taking place. In some of these cases, especially the badly infected ones, it may be wise to leave a small calibred tube through the partly sutured nephrotomy incision in the pelvis; and this also may be indicated when it is impossible to accomplish an absolutely perfect suture hæmostasis to avoid disruption of the rest of the sutured wound in the kidney.

As far as the pyelolithotomy incision itself is concerned in the first group of cases, it seems to be quite immaterial whether the pelvis is carefully closed by sutures or not. Repeatedly the pelvic incisions made in this way have not leaked though no closure has been made, and on the other hand some pelves which have been carefully sutured and then covered with fat have leaked for days after the operation. In general, one places some plain catgut sutures in the pelvic wall to approximate the incision, especially if a wide pyelotomy has been made. If a redundant pelvis has been excised and a pyeloplasty performed, it is regularly carefully sutured.

Before closing the pelvis on the wide nephrotomy incision, the double loop on the ureter should be removed, after careful palpation of the ureter above this loop, as every once in a while one finds a stone fragment in this short piece between the pelvis and the ligature. This can either be squeezed up into the pelvis and removed, or it can be scooped out with a small blunt spoon. In closing the parietal wound, it is wise to provide some drainage with a rubber dam, so that one has control of whatever leakage or bleeding may take place, and if a tube has been placed in the nephrotomy incision it should be long enough to emerge well out of the wound, for self-evident reasons.

‡ Beer, E.: Surgery, Gynæcology and Obstetrics, November, 1923.

CYSTOSCOPY REACTIONS

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Cystoscopy reactions, that is rises of temperature with various concomitant symptoms after cystoscopy, are common. To our knowledge, there are no definite data which make the exact incidence of cystoscopy reactions clear, but the majority of observers agree that such reactions are not only common, but that they may also be severe. There are a few statements in the literature which almost deny their occurrence provided proper precautions are taken, but these statements may be due to the fact that the authors considered only very severe reactions with bad end results. In the Urological Service of Bellevue Hospital cystoscopy reactions have been fairly common. Bad end-results have been rare, but in quite a number of cases the reactions have been disturbing nevertheless. Some patients have become alarmed and have refused further cystoscopic examinations and treatments; in many instances, varying degrees of discomfort and pain have followed cystoscopy.

One may question whether cystoscopists are taking all possible precautions against reactions. To do so they must know the fundamental causative factors. With the hope that some light may be shed on this subject, an investigation into the more immediate causes for cystoscopy reactions and disturbances has been made.

The urological literature contains many more or less vague warnings against the indiscriminate use of cystoscopic and pyelographic examination methods. Very little has been said which is definite and unequivocal. It is perhaps easiest to present the various opinions classified as to the points of maximal importance.

Almost everybody stresses the importance of sterile procedure and many contributions have been made to insure at least relative asepsis for cystoscopy. First, let us consider the instruments. The cystoscopes in common use cannot be sterilized in a bacteriological sense, but the new cystoscope by Leiter [1] is said to be sterilizable by heat, and Joseph's new cystoscope has at least a sheath which may be boiled.[2] Young's new cystoscope allows for aseptic manipulation after its introduction.[3] The ureteral catheters also cannot be absolutely sterilized without quick deterioration. The various methods of chemical sterilization are all open to criticism, especially if the lumen is not particularly cared for. There are no catheters made to our knowledge which can be boiled for a sufficient length of time to insure sterility. The danger of contaminating the catheters during their handling has been cleverly obviated by Grant,[4] who uses sterile paper covers, and by Kidd,[5] who uses "silk petticoats". The above-mentioned instrument by Young is the only one which takes care of two common areas of contamination, namely the rim of the

ocular which is contaminated by the eyebrows and in turn contaminates the hands, and the light cord connection which in all other instruments is not sterile to begin with. As to the patient, few authors demand a strictly aseptic preparation, *i.e.*, shaving and scrubbing of the genital area followed by an antiseptic application. The urethra of the male patient cannot be made sterile unless the most meticulous preparation is carried out. Therefore unless the most thorough and persistent efforts are made, combining all or nearly all the suggestions set forth, cystoscopy is never an aseptic undertaking.

The advice as to trauma is usually couched in general terms suggesting care and celerity. The admonition not to use too much pressure in filling a kidney pelvis for pyelography has been generally accepted and is followed by the employment of gravity for this purpose. Joseph [6] apparently alone lays particular stress on the importance of trauma. He uses a special small cystoscope of size No. 15 F. and advises the routine use of small instruments even if the optic field is small and the technic much more difficult.

The pyelographic media in use and as used at present rarely cause severe reactions. These solutions are hardly discussed any more in this connection, very much in contrast to the former vehement criticisms of collargol and similar solutions, as the former are but little irritating and may be boiled without deterioration. The present attempts to introduce lipiodol and similar heavy emulsions do not seem to find followers.

The double pyelogram is still a debatable procedure. The ban placed upon it a few years ago by Keyes,[7] Braasch,[8] and others has been lifted by some workers providing certain precautions are taken, but apparently it is still looked upon with misgivings by many.

The more specific contra-indications against simple cystoscopy and pyelography vary so greatly that little can be gained from their restatement. Warnings not to examine cystoscopically patients with prostatic hypertrophy may be contrasted with the advice offered by others to thus examine all such patients before operation. Some employ cystoscopy early in the treatment of pyelitis while others warn against cystoscopy during high temperature or the existence of an acute infection of the urinary tract. In tuberculosis many authors warn against pyelography, some warn against ureteral manipulations, and some even against the introduction of a rigid instrument into the male urethra. Westerborn [9] reports seven cases in which the introduction of a sound or a cystoscope produced miliary tuberculosis, resulting in death; all these cases suffered from genital tuberculosis aside from the kidney infection. Keyes [7] warns specifically against pyelography in hydronephrosis unless the patient can be operated upon immediately, should it become necessary. Many authors think an infected bladder a contra-indication to ureteral instrumentation and others advise not to touch the normal ureter in cases of unilateral kidney infection. Klika [10] and Narath [11] have tried to elaborate technical procedures to make ureteral manipulations safe under these conditions. Braasch [12] warns against the catheterization of a single kidney and ureter and illustrates his warning with reports of fatalities. Prostatitis is not

particularly mentioned as a contra-indication against cystoscopy, but acute cases rarely necessitate cystoscopy. The chronic prostatic infections, however, which are so commonly found concurrent with bladder and kidney infections, surely should have a bearing on the question of cystoscopy reactions.

It is difficult to attack a problem of this kind experimentally at first. But a previous analysis of cases cystoscopically examined under definite conditions promised some elucidation and was therefore undertaken. The influence of asepsis on the percentage of cystoscopy reactions cannot be clarified in this manner, but the question of trauma—a factor which depends greatly on the operator—could be solved by the comparison of different operators and their results. The material collected also throws some light on certain debatable contra-indications and contains a few cases which are remarkable from our present point of interest.

The cases which form the material for this report have been personally observed in the wards of Bellevue Hospital. All the cystoscopies which are considered include ureteral instrumentation, some with and some without pyelography. The technic used was uniform except for slight individual variations. Thorough scrubbing of the hands, cleansing of the genital area with soap and water, formaldehyde sterilization of all instruments, immersion of the cystoscope into mercury oxycyanide solution before use, and medication of the patient with hexamethylenamin were routinely employed. All solutions and all instruments which could be boiled were sterilized by heat.

Nothing was considered a positive cystoscopy reaction in this report unless the temperature rise within twenty-four hours exceeded the highest temperature of the three preceding days by two degrees F., and unless no other cause for the rise in temperature could be found. Other symptoms and signs as hæmaturia, dysuria, pain in the kidney region, and so forth were taken cognizance of, but were not recorded as reactions *per se*.

The examinations of three operators only, members of the resident staff, are included in the group. Each man had about the same amount of experience in urological work. All of them were well versed in urethral manipulations. Their particular work was observed in the hope of finding in their technic an explanation of variations in their reaction percentages, should such occur.

Altogether there were 328 cystoscopies with 63, or 19.2 per cent., reactions. The three operators used the same technic as far as sterility was concerned; they differed, however, in skill and judgment. Operator No. 1 was relatively insistent on complete investigations, though prolonged and difficult, and considered a patient's discomfort less than operators No. 2 and 3. His skill in instrumentation was average. Operator No. 2 was more composed and more considerate of the patient. His skill was fair and his touch more delicate than that of the first operator. Operator No. 3 possessed unusual skill and gentleness in manipulations, and exercised good judgment concerning the length of cystoscopic procedures. Operator No. 1 had 35

reactions in 134 cystoscopies or 26.1 per cent., operator No. 2 had eleven reactions in 62 cystoscopies, or 17.7 per cent., and operator No. 3 had 17 reactions in 132 cystoscopies, or 12.8 per cent. Of course the quality of the operator is to a certain extent imponderable, but these differences in results can hardly be explained in any other way than by reference to individual skill and judgment. All three operators used the same instruments on patients whose pathological conditions were much the same in all three groups.

An attempt was then made to group the whole material according to different viewpoints, hoping that this would throw some light on the situation. The first grouping, namely into males and females, did this rather strikingly. There were 281 males with 61 reactions, or 21.7 per cent., and 47 females with two reactions, or 4.2 per cent. The most plausible explanation for this very marked discrepancy lies in the anatomy of the urethra. The forcible straightening out of the tract in the male must exert a great deal of traction and pressure on the bulb and on the posterior urethra; the prostate and the bladder neck are also necessarily traumatized. On the other hand, the female urethra is relatively very short, is easily instrumented, and does not have a prostate. This suggests that the percentage of reactions from infections of the upper urinary tract are apparently far less common than from infections of the lower tract. Of course it is very difficult actually to draw the line between lower and upper tract infections, but we are here concerned only with the starting point, and about this there can be little doubt. The additional analysis of a small group of observation cystoscopies in which the ureters were not touched tends to confirm this. Of 33 cystoscopies in males by the previously mentioned observers seven, or 21.2 per cent., were followed by a reaction.

The question whether or not a previous infection of the urine would predispose toward cystoscopy reactions also arose. Separating the material into two groups, with non-infected and with infected urine, we get the following results: Non-infected cases: 189 with 41 reactions, or 21.7 per cent.; infected cases: 139 with 22 reactions, or 15.8 per cent. It is possible that our separation is not absolutely accurate; it is based only on the microscopic examination of the urine for pus. The classification seems to show that infection of the urine *per se* does not increase the risk of cystoscopy. If the difference of 6 per cent. is significant at all, it is in favor of the infected cases. Immunity, local or general, may be responsible. Many of the cases had unilateral kidney infections, and in all these cases the other ureter was catheterized, but there has not been a case where the other kidney has been known to have become infected through the examination.

Whether pathological conditions of the urinary tract have anything to do with cystoscopy reactions is answered by the following computation. Pathological cases: 279 with 55 reactions, or 19.7 per cent.; normal cases: 49 with 8 reactions, or 16.3 per cent. This does not seem to be a significant difference. The normal cases are those which proved to be quite negative from a urological viewpoint, but include some cases whose prostatic secretions were

not examined microscopically. The pathological cases include almost every condition encountered in urological practice.

The difference between the percentage of reactions due to pyelographic procedures and due to mere ureteral manipulations is not great. There were 251 pyelograms with 52 reactions, or 20.7 per cent., and 77 instances of ureteral manipulations only with 11 reactions, or 14.3 per cent. This seems to indicate that a pyelogram means a slight additional risk in reference to cystoscopy reactions. The fact that the catheters remain in the ureters a longer time may be partly responsible for this, as in our hospital pyelography necessitates the transfer of the patient to a stretcher and to another room.

There are only a few double pyelograms in this group, since it is the present policy to greatly restrict this procedure. Of 12 double pyelograms 5 were followed by reactions, *i.e.*, 41.7 per cent. This not only points to the inadvisability of double pyelograms, but also accentuates the fact previously mentioned that the pyelogram *per se* represents an additional injury.

Of 24 complete cystoscopic examinations on cases with tuberculous kidney lesions only four were followed by a cystoscopy reaction. Many of these cases had genital tuberculosis in addition. The group is small, but it seems nevertheless that bad results must be relatively uncommon in such cases.

When the discrepancy between males and females in incidence of post-cystoscopic reactions became evident, the question of the status of the posterior urethra and of the prostate in reference to cystoscopy reactions was a natural one. Fortunately the male group contained a number of frank chronic prostatitis cases. There must have been many others, since prostatitis is an exceedingly common complication in infections of the urinary tract, but the cases referred to here are only those in which prostatitis was the major pathological condition. Of 18 such cases, 7 showed a temperature rise after cystoscopy. It is unfortunate that this point was not watched more closely from the start, but the high percentage figure of 38.8 per cent. is convincing enough.

The warning not to employ cystoscopy if the patient has a high temperature—let us say over 102 F.—has been ignored twenty-one times in this series. There were no untoward consequences. The temperature elevations were due to diverse causes including pyelonephritis, pyonephrosis, and renal tuberculosis. In pyogenic conditions it has not been an uncommon observation to see the temperature drop after cystoscopy, especially if the affected kidney pelvis had been drained and irrigated.

The group contains two cases with bad results following pyelography. The first case was that of a young male whose chief complaint was pain in the lower abdomen. His urine contained no pus and his temperature was normal. Nothing was found except an abnormally large inferior calyx of the right kidney as seen in the pyelogram. His temperature rose to 104.8 F. during the next day and five days later his right kidney was explored. Multiple cortical abscesses were found; decapsulation was followed by recovery.

The second case was that of a middle-aged male whose chief complaint was pain in the left kidney region. Cystoscopy revealed good function of the right kidney and poor function of the left. Pyelogram showed a deformed pelvis on the left side, which led to the diagnosis of tumor of the left kidney pelvis. The patient developed anuria during the following day which persisted in spite of vigorous medical treatment. He died on the fifth day with uræmic symptoms. The permission for autopsy could not be obtained.

There was also a case in which the ureter was perforated in an attempt to pass an impacted ureteral calculus. The intended pyelogram showed the opaque solution in the peri-ureteral tissue. There were no bad results, not even elevation of temperature or pain.

Reviewing the material presented, it seems to be clear that cystoscopy reactions are due to trauma plus infection. It is quite possible of course that infection *per se* might set up a febrile reaction, but trauma seems to be such a strong contributory factor that it should be given almost equal weight. It seems that the attitude toward infected cases should be the same as toward the non-infected cases; we should strive to prevent additional infections in the former as well as to prevent primary infection in the latter. In view of the fact that most reactions are almost immediate and short-lived bacteriæmias due to organisms being introduced into the blood stream by trauma of the lower urinary tract, it seems to be a highly promising undertaking to attempt the reduction of these organisms to a minimum. Such an attempt is being made now in the Urological Service of Bellevue Hospital, and a report will be published after a large number of cystoscopies have been observed.

The question of trauma should then receive a careful inquiry. Aside from the utmost gentleness and accuracy, no specific advice occurs to us with the exception of Joseph's counsel to use instruments of as small a calibre as will permit the necessary examination.

CONCLUSIONS

1. The presence of infectious organisms and trauma are the most important factors in the causation of cystoscopy reactions.

2. Cystoscopy reactions are far more common in men than in women.

3. The skill and gentleness of the operator play an important rôle in the incidence of cystoscopy reactions.

4. Elevated temperature and infection of the urinary tract, with exception of acute prostatitis are not absolute or even common contra-indications to cystoscopy.

5. Cystoscopy should not be undertaken lightly, pyelography is still more serious than simple ureteral catheterization, and double pyelography should be performed only under the pressure of unusual circumstances.

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THE ABDUCTION TREATMENT, A STANDARD PROCEDURE FOR ALL FORMS OF FRACTURE AT THE HIP-JOINT*

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It has long since been amply demonstrated by reports from many sources that the result in fracture of the neck of the femur is more directly determined by the efficiency of the treatment than is that of other fracture. Furthermore, that in a comprehensive sense the abduction method is the only means by which efficient treatment may be applied:

Fig. 1.—The characteristic attitude of fracture of the neck of the femur.

Because it is the only method practicable for elderly and aged patients:

Because it is the only method by which resistant deformity may be definitely corrected.

Because it is the only method by which the security of apposition essential to repair of the transcervical fractures may be assured.

Since, therefore, the method is mechanically adequate, since its effects are physically demonstrable and since it is under single control, it fixes the responsibility for the opportunity for repair and therefore establishes a standard to which treatment must eventually conform. None of the statements that support this conclusion has ever been questioned by any one qualified by training and experience as a practical critic.

The abduction treatment simply because it is efficient and in accord with that of all other fractures presents a complete contrast to the established teaching and practice. This teaching, which was formulated by Sir Astley Cooper early in the last century, is summarized in a modern treatise on fractures as follows:

"The ideal object of treatment, restoration of form and function, is rarely to be attempted or even sought. The first indication is to save life, the second to get union, the third to correct or diminish displacements."

The treatment, in theory at least, was to be adapted to the patient and to the character of the injury.

To save life one would disregard the fracture in the interest of the patient.

* Read before the New York Surgical Society, November 23, 1927.

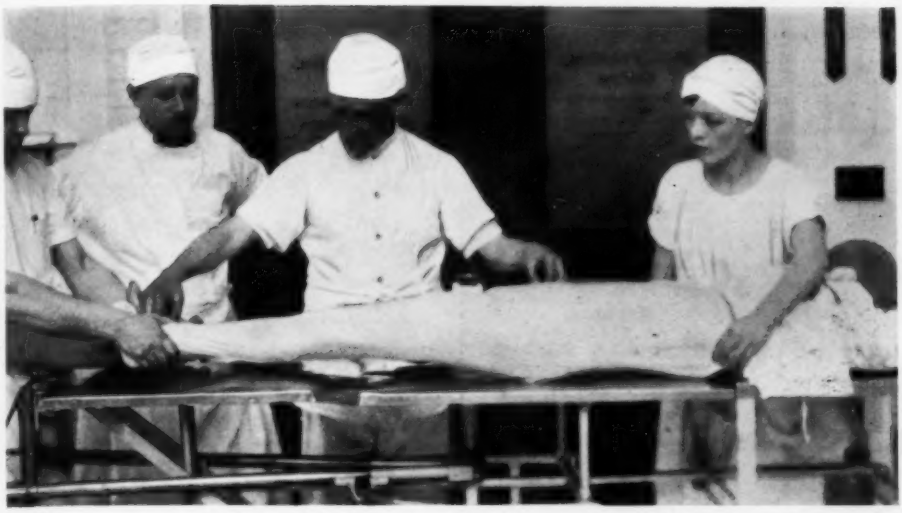

FIG. 2.—The first step in the abduction treatment. The shortening is reduced by direct manual traction and verified by measurement, the limb having been rotated slightly inward as indicated by the position of the patella.

FIG. 3.—The second step. The limbs are, under manual traction, abducted to the normal limit as indicated by the range on the sound side, upon a level pelvis, the surgeon verifying the exact correspondence of the two sides.

An intracapsular fracture being incapable of repair, the diagnosis relieved the surgeon from all responsibility for the result.

Extracapsular fractures were regarded as of little therapeutic importance because, in the words of an authority, "they get well anyhow under good or bad treatment."

Deformity, if it assured apposition, must be protected, "for to break up an impaction was a surgical crime."

Although to save life was the first consideration, the death rate has been very high, rising to 63 per cent. in one series of cases, while the functional results have been almost incredibly bad. According to Smith, "no matter whether the fracture is within or external to the capsule, whether it has united by ligament or bone, shortening of the limb and lameness are the inevitable results."

FIG. 4.—The after-treatment. Frequent changes of posture prevent bed sores and hypostatic congestion. Note the elevation of the head of the bed, the full extension at the hip and the flexion at the knee.

Function, it may be noted, received no consideration either in immediate treatment or after care, or even in the analysis of the final disability. A good result implied simply security in locomotion, and from this standpoint, according to the report of the British committee, the result in but 23 per cent. of the patients actually treated might be classified as satisfactory.

In recent years there has been a reaction from the conventional routine in favor of immediate operative intervention for fractures of intracapsular type.

The most radical of these procedures is that advocated by Koenig (*Zent. f. Chir.*, April 24, 1924). He concludes from anatomical and pathological investigations, that defective nutrition will prevent repair. Consequently in order to forestall failure, he removes the head and fashions the upper extremity of the neck into an oval, weight-bearing extremity.

The more common type of operation is that of bone-pegging, of which the latest exponent is Hey Groves (*Br. J. Surg.*, January, 1927). This in contrast to Koenig's operation is based on the proposition that lack of apposition and not deficiency in blood supply is the cause of failure and that union may be assured by adjusting the fragments and fixing them by a peg of beef bone. The operation is difficult. It is limited in its application to patients of the most favorable class and except in expert hands is either impracticable or of doubtful utility. There is, furthermore, the technical objection, that disintegration of tissue is very common in fractures of this type. This, if not extreme, may not prevent eventual repair if contact persists. If, how-

ever, a peg had been inserted, the fragments would in this event be held apart by the means designed to appose them.

The third and most conservative of the operations, if it may be classed as such, is Cotton's artificial impaction (*Surg., Gynec. and Obst.*, September, 1927). In his original paper it was stated that a complete intracapsular fracture never united under mechanical treatment, while an impaction assured union. Therefore by inducing a secondary impaction one might reproduce the conditions favorable to repair. This is accomplished, after the fragments have been apposed by manual traction, abduction and inward rotation, by repeated blows with a heavy mallet over the suitably protected trochanter until there is a sensation of something giving way, and evidence of greater security, which indicates a successful impaction. The limb is then fixed by a double plaster spica in extension, abduction and inward rotation for the usual period. As an independent procedure, secondary impaction is open to criticism both on theoretical and practical grounds.

FIG. 5.—Typical transcervical fracture before treatment by the abduction method. (See Fig. 6.)

Failure of union, if the opportunity for repair has been assured, is most reasonably explained by lack of nutrition and is usually accompanied by loss of substance. A primary fracture without displacement should interfere but little with blood supply as compared to complete separation of the fragments, and since nutrition can not be improved by further injury, the only merit of secondary impaction must be security of apposition. Cotton states that this is greater than can be obtained by the abduction method, which permits slipping of the fragments. From an extended experience it may be stated that if displacement occurs it is evidence of the faulty application of the method, since security is assured by bony contact. Full anatomical abduction requires a neck of normal length. If it had been shortened

FIG. 6.—The same fracture three months later, showing the security assured by long contact and progress of repair.

by the "giving way" incidental to impaction complete abduction would not be practicable and therefore the anatomical fixation would be less secure. The question, therefore, is of the actual physical effect of malleting the trochanter, which in the absence of any evidence other than Röntgen pictures is a matter of conjecture. Indeed, it would seem in view of the small area of the fragments that the giving way might be more reasonably explained by lateral distortion or displacement than direct penetration.

It may be noted that in Doctor Cotton's figure illustrating the plaster spica, the limb is fixed in extension, inward rotation and approximately 30 degrees of abduction. I conclude from observation that this attitude is fairly representative of the abduction treatment as it is ordinarily applied. Certainly the angle is as great as can be attained in the cases in which no anæsthetic is employed. It seems fair to conclude therefore that Cotton's success may be accepted as further evidence of the inherent capacity of the tissues for repair when opportunity is assured by utilization of the mechanics of the hip-joint.

FIG. 7.—A so-called "walking case" of incomplete fracture, showing the outward rotation of the shaft on the neck. A type of deformity that can be corrected only by the abduction method. (See Figs. 8 and 9.)

The most recent and authoritative contribution to the literature from this standpoint is that of Löfberg (*Zeit. f. Chir.*, August 27, 1927), who at a recent meeting of the Northwestern Society of German surgeons presented a large number of patients illustrating the results of the abduction treatment as a routine of hospital practice. The number of patients treated was 264—88 males, 176 females. Seventy-eight per cent. of the patients were over fifty-five years of age, the youngest seventeen, the oldest ninety-five. One hundred and seventy-two of the fractures were intracapsular. In these cases bony union and good function was attained in 67.5 per cent. Ninety-two were extracapsular, in all of which union and satisfactory function was attained. The death rate was 6 per cent. In the majority of the cases general anæsthesia, practically an essential to complete abduction, was not employed and the period of fixation was but eight weeks. These points were noted in the discussion by Anschütz, who stated that he had obtained union in 90 per cent. of the cases of intracapsular fracture by a more rigorous application of the treatment. If, however, one accepts Löfberg's results as fairly representative, they indicate that Koenig's operation is unjustified, that primary bone-pegging is indicated only in exceptional instances, and that

artificial impaction, at best a supplement to the abduction treatment is unnecessary when the anatomical splinting has been utilized to best advantage.

It may be noted that these operations represent three divergent interpretations of the old teaching. Cotton is particularly insistent on the therapeutic distinction between the intra- and extracapsular fracture in order to define the scope of artificial impaction as one of five alternatives that in his opinion may be employed with advantage in the treatment of fractures at the hip.

FIG. 8.—After forcible reduction illustrating the attitude of the limb. (See Fig. 7.)

Primary operative treatment, although not of great importance from a numerical standpoint, has been considered at some length because it obscures the main point at issue, which is to establish a standard of efficiency in the place of standardized neglect. The abduction treatment is the exponent of this reform because it is adequate to apply surgical principles in a comprehensive sense. Thus, being unhampered by the restrictions of conventional teaching the type of fracture is of interest only from the standpoint of prognosis, the two extremes in this regard being the subcapital fracture and the fissured fracture at the base.

FIG. 9.—The final result. Compare with Fig. 7.

Even if the prospect of repair were as dubious as it was once thought to be, one would still apply the abduction treatment in order to protect the patient from exhausting pain, from infected bed sores and the other dangers of persistent dorsal recumbency.

The primary essentials for a standardized treatment are surgeons qualified by training and experience to apply it.

The objections to the abduction treatment, apart from those based on the ancient teaching, as well as the various modifications in its application, may be best explained either by a

misunderstanding of the mechanical principles involved or by lack of training in plaster technic.

It may be emphasized, therefore, that the fixation of the fragments is accomplished by anatomical splinting and that the function of the plaster spica is simply to hold the limb in the attitude that makes the internal splinting effective. Consequently that the close adjustment and compression required for effective support by an external splint are not essential.

FIG. 10.—Fissured fracture at the base. See Fig. 11.

The plaster spica is the only form of support at general command and fortunately it is by far the most effective and comfortable of all splints. It is in fact, what may be called its mobile quality that has made efficient treatment practicable for patients of the class in which "the saving of life" was formerly the first consideration. The plaster spica is applied in full abduction to assure fixation by bony contact; in full extension to utilize the most resistant part of the capsule and to assure normal lordosis; in slight inward rotation to check the tendency toward the prevailing deformity and to prevent the possible inclusion of the capsule between the fragments. The long spica has the great advantage that the patient may be turned and transported as "one piece" and that movement of the sound limb is not restrained. The thoracic part is of advantage in equalizing the leverage of the abducted limb. It is applied over a thick covering of sheet wadding and need cause no constriction of the chest whatever. If desirable the front may be removed down to the pelvis, leaving the lateral supports, but this is rarely indicated.

FIG. 11.—The fissure closed by forcible abduction.

Since these advantages in a comprehensive sense can not be assured by any of the numerous modifications that have been suggested, and since what may be termed the orthodox method has stood the test of time, it should be accepted as a standard in future teaching.†

† The application of the abduction treatment is described in full detail in the ANNALS OF SURGERY for January, 1925.

Since fracture of the neck of the femur is now treated as an entity the results should be estimated from the same standpoint, for certainly nothing is more firmly established both in the professional and lay mind than that a "broken hip," in an inclusive sense, entails irreparable disability.

In Löfberg's cases 65 per cent. were intracapsular. On the other hand, in 341 cases recently reported by Stebbing (*Br. J. Surg.*, October, 1927) only 111, or 33 per cent., were of this type, yet the average age of the patients, who were inmates of a poor law infirmary, was over sixty-nine years, a period of life at which, according to Sir Astley Cooper, this is the characteristic fracture.

If the two types of fracture be fairly equal in number, and if union may be attained in 67 per cent. of those of the neck proper, and in all of the others, the prognosis for fracture at the hip under efficient treatment will compare favorably with that of other fractures of the lower extremity in patients of the same class.

FIG. 12.—The reconstruction operation—showing the stability of the improvised neck.

In a certain proportion of the transcervical fractures, defective nutrition will prevent repair in spite of favorable opportunity. In such cases there is usually an accompanying loss of substance that would embarrass function even if bone-pegging were successful. Consequently, what has been called the reconstruction operation is usually indicated. This consists essentially in providing a new bearing surface by separating the trochanter at its base and transplanting it at a lower level to the outer side of the shaft in order to restore the leverage of the abductor muscles. The head of the femur having been removed the improvised neck is inserted in the acetabulum. (Fig. 12.)

This operation has the great advantage over bone-pegging that security in locomotion, since it is not dependent upon the doubtful capacity for repair, is assured within a definite period.

It will appear, therefore, that with an adequate primary treatment and an effective operation in event of failure, fracture of the neck of the femur may be considered as fairly under surgical control.

SUSPENSION OF THE FOOT IN TREATMENT OF POTT'S FRACTURE WITH PERSISTENT POSTERIOR DISLOCATION OF ASTRAGALUS*

By John C. A. Gerster, M.D.
of New York, N. Y.

Pott's fracture with splitting off of the posterior surface of the tibia had special attention called to it in 1914 by both Cotton,[1] whose name is often used in connection with this type of ankle-joint fracture, and Kellogg Speed,[2] who termed it a "lipping" fracture. Speed's figures showed that lipping fracture occurred in at least 10 per cent. of ankle fractures, and that good results, as demonstrated by skiagrams, were not obtained in more than four-sevenths of the cases treated.

Fig. 1.—Anteroposterior view of fracture of the ankle with persistent posterior dislocation—Cotton's fracture—Speed's lipping fracture.

Treatment depends on clinical recognition of the condition, immediate reduction under anæsthesia, and enforced dorsal flexion of the foot on the leg. To quote Cotton's most recent statement:[3] "The lesion involves a break of the fibula, at or close to the joint level, a break of the inner malleolus, and a breaking away of the back edge of the tibia. Commonly enough the tibial wedge and the malleolar fragment are broken away in one piece, but even more often in two separate fragments . . . If the dislocation is reduced, then so are the fractures . . . Once we regard this clearly as a backward deformity of the foot, a lesion corresponding to Pott's, which is an outward luxation . . . we shall do much better . . . There are (other) refinements of reposition . . . and if reduction is carried out with this in mind, we are going to avoid at least some of the calamities attending upon failure of adequate reduction."

In brief, according to Cotton we are dealing with a backward dislocation which can be reduced early and kept locked in forced dorsal flexion.

Regarding after-treatment, Cotton says: "It is that of Pott's fracture save that early mobilization is absolutely essential and no weight should be

* Read before the Southern Surgical Association, December 13, 1927.

FIG. 2.—Lateral view of fracture of the ankle with persistent posterior dislocation—Cotton's fracture—Speed's lipping fracture.

FIG. 3.—One week after injury and two days after suspension of foot.

borne upon the foot for at least seven or eight weeks." [1] During convalescence there is a tendency for the callus to yield and permit a certain amount of recurrent posterior dislocation, as is shown by Cotton's statement that in the after-treatment (after removal of the plaster) protective ambulatory splints should be worn for six or seven weeks, and that these splints should be rigged with a laced leather across the face of the tibia, low down, to guard against forward slipping under weight.

That such manipulative reduction is not invariably possible is shown by Speed's advice to resort to subcutaneous extra-articular nailing where manipulation fails,[2] and by Dowd's report [4] of his resort to a lengthening of the tendon of Achilles in two cases with persistent posterior backward displacement of the tarsus, in order to obtain adequate reduction.

FIG. 4.—One week after injury and two days after suspension of foot. Anteroposterior view.

However, Cotton, in closing the discussion of his 1914 paper, said: "With regard to cutting the tendon of Achilles I have done that in tarsal fractures, but I dislike to do it, because a certain amount of atrophy is caused and it takes a while for the function to come back. . . . Another reason why I dislike to do this cutting is that in putting the cases up in dorsal flexion, it is the Achilles tendon that is depended on. Some cases can not be treated without open operation, which is undesirable."

Wilson and Cochran [5] advise Z-shaped tenotomy of the tendon of Achilles or application of continuous traction to the foot, with the comment that "tenotomy in adults often leads of itself to considerable disability and the traction method is preferable, namely, a metal pin † over the os calcis in conjunction with a Thomas splint, using 15 to 25 pounds at first." They also mention operative reduction.

Roberts and Kelly suggest the use of traction by a Sinclair skate (plantar foot board) and adhesive plaster with pulley extension. Steinmann's nail traction from the heel may be used also.† They advise that weight bearing

† To digress for a moment, the author would strongly advise against resorting to a Steinmann pin or other form of skeletal traction, as advised by some writers, as the parts invariably show extensive ecchymoses and Steinmann in his original paper expressly states that the pin must not pass through the "fracture hæmatoma" because of the dangers of infection.

be postponed for from ten to fifteen weeks in severe cases and then very cautiously permitted.

Kellogg Speed [6] also advocates nailing of fragments in correct position through a small skin opening.

In a recent case of the writer's, a stout, plethoric, middle-aged, alcoholic man, with this type of fracture, presented such an extensive ecchymosis and swelling of the ankle and leg that any operative interference would have been fraught with the gravest danger to both limb and life. Two attempts at plaster-of-Paris immobilization under general anæsthesia were unsuccessful; then simple maintenance of the foot in elevation was found to produce entirely effective reduction, the weight of the leg being sufficient to carry the lower end of the tibia backward into its normal position. Active flexion and extension of the ankle was practiced almost from the first—an additional advantage over plaster-of-Paris immobilization. Hyperextension of the knee was prevented by suitably adjusted support.

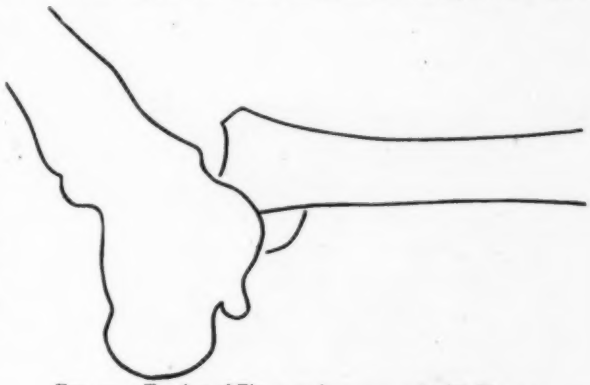

FIG. 5a.—Tracing of Fig. 2, to be compared with Fig. 10.

Henry DeF., aged sixty-two, sustained a Pott's fracture of the left ankle, February 17, 1924, and was admitted to the Lenox Hill Hospital, service of Dr. DeWitt Stetten. There was extreme ecchymosis and swelling involving the ankle and lower half of the left leg. X-ray revealed fracture of both internal and external malleoli, together with a chipping-off of the posterior articular lip of the lower end of the tibia. (Figs. 1 and 2.) Two successive attempts at reduction in plaster-of-Paris (February 18 and 20, respectively) were unsuccessful. February 22, suspension of the foot by means of adhesive plaster applied to the sole and posterior aspect of the heel ‡ produced

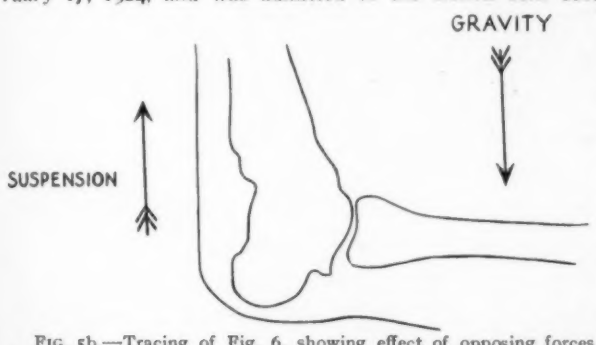

FIG. 5b.—Tracing of Fig. 6, showing effect of opposing forces of suspension and gravity in maintaining reduction and permitting active motion.

‡ I have since had several cases in which simple suspension of the foot on the orthopædic table, allowing the weight of the unsupported leg to have its constant effect during manipulation of ankle fractures, without anæsthesia, facilitated manipulative replacement of fragments and the subsequent application of plaster splints.

Cotton [8] (Dislocation and Joint Fractures), in discussing fractures of both bones of the leg just above the ankle-joint, shows (Fig. 1036c, page 569) a sling of adhesive plaster for supporting the foot when using a posterior splint, evidently to prevent anterior angulation of the fragments.

an effective reduction. (Figs. 3 and 4.) The foot being elevated and fixed, the natural weight of the leg was sufficient to maintain reduction. Properly adjusted suspension under the knee-joint prevented hyperextension and yet did not interfere with maintenance of reduction at the ankle. At first, slight traction (five pounds) to the foot by means of a Sinclair skate was instituted. This proved to be superfluous and was discontinued after three days. X-rays taken on March 25 showed that reduction was maintained. During all this time free active dorsal and plantar flexion of the ankle was practiced. Suspension for five weeks was followed by physiotherapy for three weeks more. The patient was discharged on April 16, 1924.

During the first week of hospitalization there was some fever, but this subsided. The patient was seen and examined three years later. There was no disability and he had good function. Figures 5, a and b, illustrate the mechanics involved.

From the foregoing we consider that this method, which maintains reduction and at the same time permits voluntary motion, possesses sufficient merit to be borne in mind and to be tried in severe types before resorting to Cotton's method of plaster immobilization or to operative reduction.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held November 23, 1927

The President, Dr. Frank S. Mathews, in the Chair

RUPTURED POPLITEAL ANEURISM. ENDO-ANEURISMORRHAPHY RECONSTRUCTIVE TYPE

Dr. Alfred Stillman presented a man, thirty-seven years old, colored, who noticed five weeks before admission to Roosevelt Hospital, August 3, 1927, a small lump behind his right knee. The lump was not painful, but it had gradually grown larger and interfered with walking. Examination showed a swelling of the entire popliteal space, not tender but hot and semi-fluctuant. It looked like an abscess. There was no thrill felt or murmur heard over it and there was no expansile pulsation. The dorsalis pedis pulse was absent. Aspiration of the tumor obtained bright blood. His Wassermann returned four plus.

August 9, 1927, a tourniquet was applied and an incision six inches long was made down the middle of the popliteal space. On incising the deep fascia, clots extruded. These were wiped out until a cavity presented with smooth shining walls and at the bottom a groove about three inches long connecting two orifices. With a vaselined silk stitch, starting proximal to the upper opening and ending distal to the lower, the edges of this groove were approximated. The tourniquet was loosened and a little bleeding occurred, soon stopped by one or two more stitches when the tourniquet was entirely removed. A second row burying the first was then applied and the wound closed with a rubber tissue drain. The cavity seemed too big and the skin too tight for closure in the method suggested by Matas. The dorsalis pulse was immediately felt and has continued present ever since. The patient made an uneventful recovery and was discharged September 6.

Matas says the obliterative operation is the simplest, most conservative and safest of the radical operations for the cure of aneurisms of the extremities. Since he has learned by increasing experience how to determine the efficiency or inefficiency of the collaterals by four practical and dependable tests, namely: (1) The hyperæmia reaction or modified Moszkowicz color tests; (2) the preliminary occlusion of the main artery close to the proximal pole of the sac with pliable and removable bands; (3) oscillometric manometer, to determine the peripheral blood-pressure after temporary occlusion of the main artery, and lastly (4) the clinical evidence of a persistent circulation and nutrition of the peripheral parts in spite of the permanent absence of the peripheral pulses, he finds the indications for the reconstructive operation less frequent.

In reporting October 28, 1926, 478 operations, he said 80 per cent. were of the obliterative type and 20 per cent. of the reconstructive or restorative. Deaths directly attributed to the operation (apart from the aortic) do not exceed 4.5 per cent., the gangrenes 3.5 per cent., secondary hemorrhages 1.6 per cent., and relapses in less than 1 per cent.

SPONTANEOUS HEALING OF OSTEOMYELITIS

Dr. Richard Lewisohn presented a boy three years old who, when first seen in the Dispensary of Mount Sinai Hospital on July 15, 1927, gave the following history: Simultaneously with an attack of scarlet fever thirteen weeks ago the left leg began to swell from ankle to knee. He was in another hospital for four weeks, where a small subcutaneous abscess in front of the tibia was aspirated and a few drops of pus were obtained. His temperature was slightly elevated, ranging between 99 and 100°. The left leg showed a slight thickening anteriorly. There was some tenderness on pressure on the anterior aspect of the tibia. The Wassermann reaction was negative. X-ray examination (Fig. 1) showed a destructive process involving the lower half of the tibia. The boy was subsequently admitted to the hospital. An X-ray picture taken August 16 showed about the same findings as those reported July 15. Under expectant treatment this process cleared up gradually and the boy was discharged from the hospital September 16. An X-ray examination taken recently (November, 1927) shows a normal tibia. (Fig. 2.)

Doctor Lewisohn presented this boy in order to show that in rare instances an osteomyelitis can heal completely without surgical interference and without formation of a sequestrum.

Dr. Morris K. Smith showed three radiographs in connection with Doctor Lewisohn's case and said that the patient, a boy of nineteen, applied at the dispensary of St. Luke's Hospital in May, 1926. He had been ill for a month and had spent part of this time in bed. He described his illness as influenza followed by rheumatism. When he presented himself the right arm was swollen, the humerus felt thickened and was somewhat tender. There was no point of fluctuation and no marked redness. The first picture was taken in May, 1926, when he was first seen. He was afebrile and not suffering pain. He was followed for a month after which he disappeared from view. He finally showed up in January, 1927, about eight months after the first radiograph and at this time his arm was clinically well. He had done rather strenuous exercise with the arm. The last picture taken showed the bone healed except for one small area, which, however, at some time may result in an abscess.

Dr. Walter M. Brickner remarked that the text-books say very little concerning spontaneous recovery of acute osteomyelitis, but the literature is not entirely silent on the subject. He himself had referred to such spontaneous cures about twenty years ago in "Surgical Suggestions". A few years ago Frazier, of Edinburgh, expressed the opinion that acute osteomyelitis in children that subsides spontaneously is almost invariably a pneumococcus infection. The speaker had seen a few cases of spontaneous subsidence of acute osteomyelitis in children and he had also seen two cases in adults in which a post-traumatic, localized, acute osteomyelitis went on to spontaneous recovery. In one of these cases an osteomyelitis of the lower end of the radius was followed by an eventually fatal septic endocarditis. The local signs had completely disappeared and when the bone was explored a few weeks after the onset nothing was found.

Dr. Howard Lilienthal said that in cases of acute septic osteomyelitis

FIG. 1.—Osteomyelitis of tibia.

FIG. 2.—Recovery from osteomyelitis; same tibia as shown in Fig. 1, six months later.

surgery is certainly required for the relief of tension. In the more chronic cases X-ray examinations may point the way to the proper surgical procedure such as the removal of sequestra. In the main the subject resolves itself into two headings: (1) That the septic cases require some form of drainage, and (2) that the more chronic ones should be observed and that local retention should be relieved. Before the days of Röntgen, exploratory operations were distinctly more frequent than they are at present.

THROMBOCYTOPENIC PURPURA—SPLENECTOMY

Dr. Richard Lewisohn presented a boy, fifteen years old, who was admitted to Mount Sinai Hospital, December 21, 1925 He gave the following history: Following a tonsillectomy performed three years ago in the dispensary the boy had three profuse hemorrhages, requiring hospitalization for one week. During the last two years he has suffered from epistaxis every month which lasted for about one week. A tooth extraction two years ago was followed by bleeding over a period of twelve hours.

The status was essentially negative. Liver and spleen were not palpable. There were numerous ecchymotic spots on the legs. Blood examination (Doctor Rosenthal) presented the following findings:

Hæmoglobin, 83 per cent.	Polymorphonuclear neutrophiles, 68 per cent.
Red blood-cells, 5,400,000.	Polymorphonuclear eosinophiles, 2 per cent.
Color index, 0.7.	Lymphocytes, 27 per cent.
White blood-cells, 14,500.	Chyelocytes, 3 per cent.

Platelets, 52,000.

Bleeding time three and a half minutes; no clot retraction within twenty-four hours. Coagulation time five and a half minutes. Tourniquet test negative within five minutes.

On the day following the admission several petechiæ were noticed on the lips and in the mouth.

December 25 he bled freely from the buccal mucous membranes. Many petechiæ were observed on the soft and the hard palate.

January 4 the stool contained blood.

Splenectomy was performed January 16 through a left subcostal incision. The abdominal wound was sutured in layers. A rubber tube was placed into the posterior angle of the wound. The patient was severely shocked following the operation, but improved rapidly after twelve hours. He developed a crop of petechiæ on the chest and the right eyelids following the operation, which faded after a few days. He showed severe secondary post-operative anæmia a few days after the operation.

He has been in perfect condition since he left the hospital.

The blood picture (taken November 18, 1927) presents the following findings:

Hæmoglobin, 85 per cent.	Lymphocytes, 46 per cent.
Red cells, 4,800,000.	Monocytes, 8 per cent.
White cells, 7800.	Coagulation time, ten minutes.
Platelets, 140,000.	Bleeding time, one minute.
Polymorphonuclear neutrophiles, 42 per cent.	Tourniquet test, negative.
Polymorphonuclear eosinophiles, 4 per cent.	Clot retraction, normal.

The blood platelets are still slightly diminished. The rest of the blood picture is normal.

Dr. Edwin Beer called attention to the fact that Doctor Lewisohn's patient did not conform to the usual type of thrombocytopenic purpura in

view of the bleeding time being only three and a half minutes. Duke some years ago emphasized the fact that in this type of purpura the bleeding time is usually prolonged. In some cases, after a slight prick of the finger or ear the bleeding continues for forty or fifty minutes; and even then has to be stopped by compression.

At a recent meeting of the Bellevue Alumni Association, in which the speaker took part in the discussion on surgery of the spleen, he was able to report for the staff of Mount Sinai Hospital, 25 splenectomies for thrombocytopenic purpura, 22 being done in chronic and subacute cases and 3 for acute purpura. Of the former, all but one were saved; whereas of the latter, all died. These chronic cases are apparently very strikingly improved by splenectomy, if not absolutely cured. Some of the cases operated upon by the Mount Sinai Hospital staff have already run six years in perfect health.

HÆMOLYTIC ICTERUS—SPLENECTOMY

Dr. Richard Lewisohn presented a woman, forty-two years old, who was admitted to Mount Sinai Hospital, September 24, 1926. She had complained of general weakness and swelling of her legs during the last five years. She had lost 16 pounds in two years. Her hæmoglobin, taken one year ago, was 45 per cent. It had fallen to 30 per cent. recently. There was no bleeding from the mucous membranes.

She was a rather stout woman with a yellow color of her skin. The conjunctivæ were slightly icteric. No petechiæ. The spleen was markedly enlarged, reaching down to the crest of the ileum and extending over to the median line. The notch of the spleen was palpable. The liver was palpable on deep inspiration.

Examination of the blood (by Doctor Rosenthal) showed:

Hæmoglobin, 32 per cent.	Polymorphonuclear neutrophiles, 75.5 per cent.
Red blood-cells, 2,672,000.	Lymphocytes, 20 per cent.
White blood-cells, 3400.	Reticulocytes, 8 per cent.
Platelets, 80,000.	Monocytes, 4.5 per cent.

The fragility test showed an increased fragility of the red blood-cells. The Van den Bergh test presented the following:

Direct: negative. Indirect: 1:83000. 1, 2 mg. per 100 cm. The urine was negative for bile. Urobilin was present; 24-hour specimen: 54 mgms. The blood chemistry was normal for the nitrogenous bodies.

The stomach contents showed an anacidity (free acid, 0, total acidity, 35).

The liver function test showed no evidence of liver damage.

Doctor Rosenthal's conclusions were: The secondary anæmia, the increased fragility of the red blood-cells and the increase in the reticulated red cells suggest a hæmolytic icterus. The low platelet count makes the prognosis better, if a splenectomy is performed.

Two pre-operative transfusions of 500 c.cm. of citrated blood were given to the patient October 7 and October 10 and the hæmoglobin was raised from 32 per cent. to 60 per cent.

October 15 a splenectomy was performed through a left subcostal incision. The abdominal wound was closed in layers and one tube was placed into the subphrenic space.

The patient made an uneventful recovery. She is perfectly well at present.

The blood examination (November 14, 1927) shows:

Hæmoglobin, 85 per cent.
Red cells, 6,300,000.
White cells, 8600.
Platelets, 510,000.
Polymorphonuclear neutrophiles, 59 per cent.
Lymphocytes, 32 per cent.
Monocytes, 9 per cent.

Fragility of red cells: No hæmolysis, 0.8 per cent. to 0.6 per cent.; partial hæmolysis, 0.58 per cent. to 0.38 per cent.; complete hæmolysis, 0.36 per cent. to 0.2 per cent.

The fragility of the red cells is unchanged. The blood is otherwise normal.

FIG. 3.—Carcinoma of the cystic duct.

CARCINOMA OF THE CYSTIC DUCT

DR. RICHARD LEWISOHN presented a woman, forty-two years old, who was admitted to the Mount Sinai Hospital, November 3, 1926. About six months ago the patient noticed a mass in the right upper quadrant, which has gradually increased in size. The mass was always movable. She has complained of belching and occasional vomiting. She has lost 15 pounds during the last six months.

Examination revealed a large, ballottable mass in the right upper quadrant, reaching below the level of the umbilicus. Differential diagnosis rested between a very large, distended gall-bladder and a hydronephrosis. Cystoscopy did not reveal a very marked difference between the function of the right and the left kidney. The pyelogram showed no abnormality. X-ray of the gastro-intestinal tract failed to show any abnormality.

Pre-operative diagnosis: Hydrops of gall-bladder, due to a stone in the cystic duct.

November 16, in local anæsthesia, the abdomen was opened through a right upper rectus incision. A very large gall-bladder presented itself which had the size of a pear. The gall-bladder was aspirated, its contents were white. A mass was felt in the cystic duct. A typical cholecystectomy was performed. The resected specimen showed that we were dealing with a tumor of the cystic duct. The line of dissection had not gone quite beyond

the tumor. Therefore the cystic duct was freed for another one-half inch to the level of its entrance into the common duct. Thus the dissection could be performed in healthy tissue. The base of the cystic duct was tied. The gall-bladder did not contain stones. No metastases were noted in the liver or in Winslow's foramen. The abdomen was closed in layers, after a tube and a small packing had been placed in the abdomen.

The pathological report showed present an early adenocarcinoma of the cystic duct with invasion of the gall-bladder wall. The patient made an uneventful recovery and has gained ten pounds since the operation.

MULTIPLE COMPLICATIONS FOLLOWING APPENDICECTOMY

Dr. DeWitt Stetten presented a girl, ten and one-half years of age, who was operated on at the Fifth Avenue Hospital, January 27, 1925, for a ruptured appendix. The wound was closed without drainage, but was subsequently reopened and drains were inserted. Two days after operation a bilateral pneumonia developed, followed by a left-sided, upper, anterior empyema, for which a simple thoracotomy was done on March 9, 1925. The appendix wound gradually healed, but the empyema wound continued to drain with intervals of closure until March 18, 1925, when the reporter saw the patient for the first time. She then complained of cramp-like abdominal pains to the left of the umbilicus, associated with vomiting. The child was very much emaciated. There was a solidly healed transverse scar in the right lower abdomen with no evidence of hernia. There was some sensitiveness and slight rigidity around the umbilical region, but no visible peristalsis nor palpable enterospasm. There was a small scar of an old empyema wound in the left fifth interspace at the anterior axillary line, with a slight purulent discharge from the posterior portion of this scar. There was some dulness over the left chest posteriorly with diminished voice and breathing. The temperature was slightly subnormal, and the pulse 120. The patient was vomiting. She was immediately referred to the Lenox Hill Hospital. After admission her vomiting and cramps ceased. May 23, the patient again began complaining of cramp-like abdominal pains, and again began to vomit. This vomiting continued, and May 25 the patient was operated on by Dr. P. K. Sauer, with a diagnosis of acute ileus due to post-operative peritoneal bands. A median incision was made and a definite band constricting a loop of ileum near the ileocæcal region with several other bands binding down loops of ileum were found. The definite constricting band was divided between ligatures and excised, and the other bands were also cut and excised. The abdominal wall was closed in the usual fashion. The following day the patient seemed much improved with only slight pain and vomiting. May 27, the patient again began to vomit, and on May 28, the vomiting having continued with cramp-like pains around the umbilicus, the patient was reoperated on by Doctor Stetten with a reopening of the recent abdominal wound, and a slight extension upward of the incision. There was a loop of ileum found tied down by a definite fibrous band in the ileocæcal region. Numerous other loops were found bound down, kinked and adherent to the pelvis. The omentum was adherent to the anterior abdominal wall to the left of the recent incision. After separation of the omentum from the anterior abdominal wall, and resection of portions of it, the fibrous band constricting the loop of ileum was divided and the constriction released. The other bands binding down and kinking the loops of ileum in the pelvis were separated, and the abdomen was closed in the usual fashion. The patient stood the operation remarkably well considering her exhausted condition, and the vomiting ceased within twenty-four hours. The convalescence from the abdominal condition was

uneventful, with primary union of the larger portion of the wound, except for a small granulating area around the umbilicus. The empyema wound, which had healed, reopened with a considerable discharge of pus, and X-ray examination, including injection, showed a fistula running toward the apex of the chest. June 22, 1925, a thoracoplasty was done by extension of incision upward from the fistulous opening, and resection of two inches each of the fourth, third and second ribs. A large empyema cavity beneath these ribs was opened, which contained at least six ounces of thick greenish pus. The anterior wall of this cavity, made up of dense scar tissue, almost cartilaginous in consistency, was resected after the usual ligation of the intercostal vessels. The cavity, of which the upper portion corresponded almost to the apex of the thorax, was kept widely open by gauze tamponade. Thereafter the patient's convalescence was uneventful. She was finally discharged from the hospital on September 2, 1925, with the abdominal wound closed and the thoracic wound almost healed. Her weight was 51 pounds. A moderate herniation of the centre of the median abdominal, and of the outer angle of the lateral abdominal incision has developed. Aside from this the patient has remained perfectly well and her weight on discharge from the hospital has been doubled.

The case is presented as an example of extreme endurance and of unusual toleration to a succession of insults to the organism.

Dr. Frederic W. Bancroft said he had seen a similar case. The patient had an acute appendicitis, then a pelvic abscess which was drained; then she had a collection in the left lumbar gutter which was drained, a subphrenic abscess on the left side also drained, followed by empyema on the left side also drained. This patient is now well as far as is known.

RESECTION AND RECONSTRUCTIVE ARTERIORRHAPHY FOR BRACHIAL ARTERIOVENOUS ANEURISM

Dr. DeWitt Stetten presented a woman, age thirty-three years, first seen May 31, 1927, with a history of having been stabbed in the right cubital fossa May 7. There was profuse bleeding from the wound, which was sutured in the Beekman Street Hospital. The wound healed by primary union, but some difficulty in extending the arm persisted. The patient held the arm in a slightly flexed position. In the right cubital fossa, just below the three-quarter inch, healed, transverse scar, was a slight, tense swelling, with a distinct expansile pulsation and a definite thrill transmitted downward. On auscultation a loud roaring bruit was heard, also transmitted downward. There was slight limitation to extension of the elbow, but flexion was almost normal. There was no swelling or cyanosis in the forearm, nor were any dilated veins noted. The radial and ulnar pulse could barely be felt at the right wrist, but both radial and ulnar pulse could be distinctly felt at the left wrist. The patient was referred to the Lenox Hill Hospital, and on June 6, 1927, she was operated on by Doctor Stetten with a diagnosis of traumatic aneurism, possibly arteriovenous, of the right brachial vessels. Under an Esmarch bandage applied to the arm, a longitudinal incision was made over the tumor. The bicipital fascia was divided and a thin aneurismal sac, about the size of a small walnut, was exposed. The sac was moderately adherent to the surrounding structures, particularly to the brachialis anticus and the pronator radii teres muscles, from which it was carefully separated. The median nerve was exposed but not injured during the dissection, and retracted inward. Two rather small veins were found to run from the upper pole and two rather dilated veins ran into the lower pole of the aneurismal

sac. The sac was seen to spring from a rather small brachial artery, about one-half inch above its bifurcation into the radial and ulnar. The two small veins running from the upper pole of the sac were doubly ligated and divided. The sac was opened and a small, partially organized, reddish-brown thrombus was removed. The openings of the two dilated veins entering the lower pole of the sac were now distinctly seen, as was also the slit in the brachial artery with the proximal and distal openings of the vessel. Venous blood was seen to enter this sac through vein openings when the veins were not clamped. The dilated veins entering the lower part of the sac were doubly ligated and divided and the sac was then resected, leaving a sufficient flap of sac wall at the slit in the brachial artery for a satisfactory arterial suture. Arteriorrhaphy was now done with a double suture of fine silk. (Fig. 4.) The Esmarch bandage was apparently never completely successful, as Carrel clamps were required to control the arterial bleeding during the arterial suture. After the suture of the artery the Esmarch bandage was removed,

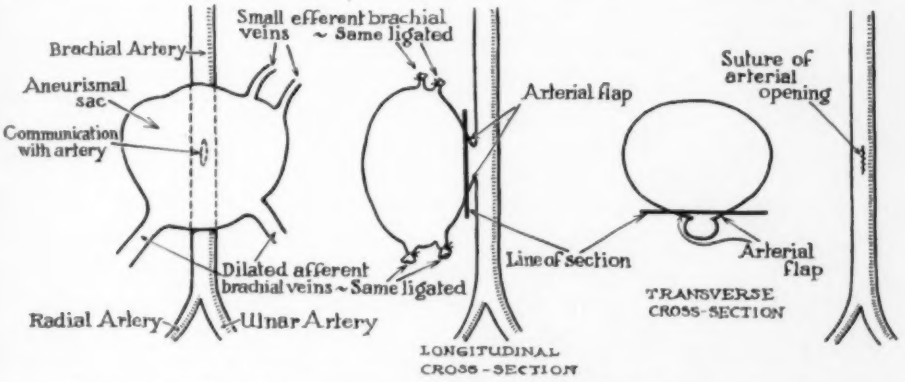

FIG. 4.—Resection and reconstructive arteriorrhaphy for brachial arteriovenous aneurism.

after having been in place about fifty minutes. Distinct pulsation was noted above and below the arterial suture, and there was no oozing at the suture line. The bicipital fascia and skin were then sutured. A firm bandage was applied with an anterior splint holding the elbow in extension. The radial pulse could be distinctly felt after the operation. The wound healed by primary union, but after the operation the patient was absolutely unable to actively move her fingers or her wrist. There also appeared to be some weakness in the biceps, triceps and suppinator longus muscles, but there was no disturbance of the sensation in the distribution of the median, ulnar, or musculospiral nerves. All the muscles of the forearm responded actively to Faradism, but possibly a little less than on the left side. The biceps, triceps, ulnar and radial reflexes were all absent. On the left side these were all present and equal. The radial pulse remained distinctly perceptible and the thrill and bruit in the cubital fossa had disappeared. The patient was given daily Faradism, massage and passive motion, and a cock-up, molded, plaster-of-Paris splint was applied to the forearm and hand. About three weeks after operation patient began to move her wrist and fingers. This rapidly improved, and on August 20, 1927, patient was discharged from the hospital with good motion in the elbow, wrist and fingers. Her condition at present is most satisfactory. There is perfect motion in the elbow-joint and perfect function in the right forearm and hand, with excellent grasping power of the hand and no muscular atrophy. No thrill can be felt and no bruit heard in the cubital fossa, and there is a fair radial and ulnar pulse,

almost as good as on the left side. Examination with the Pachon oscillometer at the midforearm shows, right: blood-pressure 120, oscillations 1; left: blood-pressure 120, oscillations one and a half.

The case is presented primarily to show the relative simplicity of resecting an arteriovenous aneurism with preservation of the arterial blood supply, and without ligation of the main arterial trunk. The case also demonstrates the menace of the Esmarch bandage as a possible cause of an ischæmic paralysis.

Dr. Hugh Auchincloss said that there is a question as to whether the tourniquet on the arm was the cause of the temporary paralysis in this case. It brings up an interesting subject. The opinion is largely held that a tourniquet should be allowed to stay on only a certain length of time. Some say it should be left on a few minutes, loosened, and put on again. He did not believe the question of time has very much to do with it. Over fifteen years ago he operated on a hand for four hours, with the tourniquet not released at all. The patient had no ill effects whatever. He recently operated on a patient with the tourniquet on for well over three hours and several times had operated with a tourniquet on for over two hours. He should like to emphasize the fact that it is not the length of time the tourniquet is on the arm, nor the shutting off of circulation that matters anything like as much as the way in which it is applied.

The tissues are capable of a certain amount of resistance to pressure. If pressure be made over a broad area, the resistance offered by the tissues is of course very much greater than when pressure is exerted over a very small area. It would be far easier to break the skin and cut through the tissues by twisting a wire than by pulling a broad bandage as tight as one could. If one places at least two, often three, towels, that have been folded longitudinally several times, around the arm so as to make a broad pad and outside that pad wind an Esmarch bandage, it is possible to operate for long periods of time without causing an ischæmic paralysis. It is peculiarly adaptable for operating on osteomyelitis cases. It has been possible to operate on suppurative osteomyelitis of the tibia or fibula without clamping any blood-vessels throughout, with practically no loss of blood. Apply the dressings, elevate the leg, and have less post-operative bleeding and absorption than when the tourniquet has been left off. Far more care should be taken not to severely crush the tissues by a tourniquet. A tourniquet that crushes tissues severely may cause an ischæmic paralysis in a short time, whereas one applied without crushing may be left on for longer than is generally conceded.

Dr. Howard Lilienthal said that much depends upon the location chosen for the tourniquet. Towels or pads are invaluable to place over the limb and the elastic tourniquet applied over them. In making constriction above the elbow special care should be taken since nerve disturbance is common following the use of the tourniquet here. Nerve disturbance never follows elastic constriction over the forearm.

To illustrate a curious freak of hysteria, Doctor Lilienthal recalled the case of a girl of seventeen from whose forearm he removed a neurofibroma

many years ago, using a tourniquet around the upper arm. There followed a complete loss of sensation of the left hand and arm. The anæsthesia gradually spread over the entire left half of her body from the head down. She was unable to use the hand at all, and the member became soft, moist and like that of an infant.

A test of vision revealed the characteristic contraction of the visual field for red. After nearly a year this girl was admitted to a home for chronic invalids. She came to Doctor Lilienthal's office twice a week and feeling certain that she would one day recover, he impressed upon her that there would probably be a sudden return of function, and one day his prediction was justified and she remained well for years afterward. He had not seen her recently. The anæsthesia had persisted for more than a year and a half.

DOCTOR STETTEN said that the paralysis was obviously not due to a direct nerve injury from compression by the Esmarch bandage. He made this statement because there was absolutely no trace of sensory disturbance and because there was a total, unselected paralysis of all the muscles of the forearm and hand, with no interference in the Faradic response. If the paralysis was ischæmic in character, it was because of a direct muscular ischæmia with subsequent muscular degeneration, but this seems rather improbable, as the Esmarch bandage was only on for fifty minutes and never produced a complete hæmostasis. The veins when they were not clamped bled into the aneurismal sac and after the sac was resected the artery bled so much that it was necessary to apply Carrel clamps above and below the opening in the artery, while the arterial suture was being inserted. He was inclined to believe that they were dealing with an hysterical paralysis, an opinion confirmed, in spite of the apparent loss of reflexes, by the rather abrupt, complete recovery, without any atrophy whatsoever.

INTRAPERITONEAL RUPTURE OF URINARY BLADDER DURING ABDOMINAL EXAMINATION

DR. DEWITT STETTEN presented a woman, age sixty-five years. On September 23, 1924, the patient had a ventral fixation with anterior colporrhaphy and colpoperineorrhaphy done for a complete prolapse of the uterus, with prolapse of the posterior and anterior walls of the vagina. On March 10, 1927, she was operated on at the Lenox Hill Hospital for internal hemorrhoids, which were removed by clamp and cautery. There was never any indication of any neurological disturbance and she seemed to void quite satisfactorily after the operation, never requiring catheterization. About a week after operation she began to complain of some abdominal distention and discomfort which was not relieved by colonic irrigation. There was no vomiting. March 19, Dr. Walter T. Stenson reported that he had examined the patient a short time before. The abdomen had been somewhat distended and while palpating the abdomen something seemed to give way under his hand, and the distention apparently disappeared. Doctor Stetten immediately examined the patient, who looked somewhat cyanotic and collapsed, although the pulse was 80, and of good quality. The temperature was normal. The abdomen was slightly distended and somewhat sensitive. X-ray examination showed several loops of distended ileum and apparently collapsed colon, and a diagnosis of intestinal obstruction of some sort, possibly due to a carcinoma of the

colon, was made. Immediate operation was decided upon. A midline, suprapubic incision was made and a large amount, about 2000 c.c. of free, straw-colored fluid, at first thought to be ascitic fluid, was found in the abdominal cavity. The fluid was removed by suction. Thorough inspection showed no evidence of intestinal obstruction, although there was some distention and injection of the lower ileal loops. The uterus was found to be adherent to the anterior abdominal wall from the former operation, and below this was found the urinary bladder, of tissue-paper thickness, with an irregular, intraperitoneal tear at the fundus about two inches in length. It was then obvious that the intra-abdominal fluid was urine. The tear was closed by a triple suture line. An indwelling catheter was inserted into the bladder, the pelvis was drained, and the abdomen was closed in the usual fashion. About nine days after operation some urinary leakage was noted, which gradually ceased, but the patient had great difficulty in voiding spontaneously. Spontaneous voiding began about a month after operation, but frequent catheterization was necessary. Neurological examination by Dr. Russell G. McRobert showed some early combined degeneration of the posterior columns and the pyramidal motor tracts. By the time, however, of the patient's discharge from the hospital, May 10, 1927, voiding was practically normal, and since that time there has been no disturbance.

It is plain that this patient suffered from a chronic post-operative distention of the bladder, which was overlooked until she began complaining of her abdominal discomfort. According to the neurologist there is some neurological factor, but the fact remains that the wall of the bladder was extremely thin. Doctor Stenson, who is an extremely gentle and careful man, used no more than the average force in making the abdominal examination, showing that under certain conditions this is quite sufficient to produce a rupture of the bladder.

THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR AND CERTAIN DISEASES AND DEFORMITIES OF THE HIP-JOINT

Dr. Royal Whitman read a paper with the above title, for which see page 442.

BRIEF COMMUNICATIONS

SARCOMA OF THE OVARY WITH UNUSUAL ORAL METASTASES

A GIRL of sixteen was referred to the service of Dr. V. P. Blair, of the Department of Surgery, Washington University Medical School, and Barnes Hospital, of St. Louis, Mo., because of loose, painful teeth and swollen gums. She was unable to bite and could take only very limited amounts of anything by mouth.

About six weeks previously, she had had pain in all her lower teeth which spread to the uppers, the teeth became loose and the gums sore. She had had many kinds of treatment, the condition having been diagnosed pyorrhœa; and seven teeth were extracted just before she was seen on this service. She had become very weak and mentally dejected by the time we saw her.

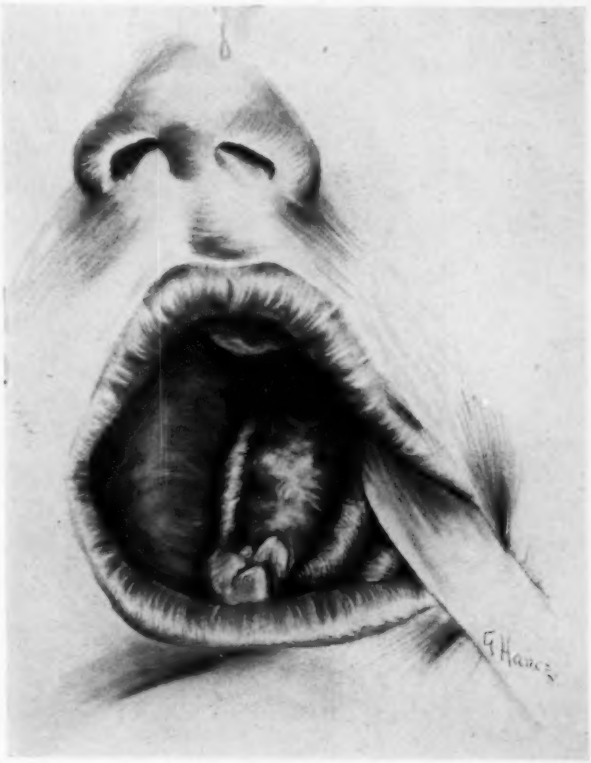

FIG. 1.—Shows the large granulomatous mass found in all four molar regions.

The upper and lower molars were missing and most of the remaining teeth were loose. The sockets in the four molar regions showed an exuberant mass of dirty red granulations 2 cm. across. In some areas the mucous membrane appeared to be growing over the granular mass. The breath was foul and the patient was weak, toxic and in mild acidosis. (Fig. 1.)

X-ray showed some bone destruction in the lower molar region and of the peridental membrane throughout both jaws. (Fig. 2.) The patient was probably below normal mentally, large for her age, was almost blind, and had coloboma iridis and epicanthus of both eyes. (A brother had a coloboma in one eye.) The forehead was low; speech was of muffled lisping type.

There was nothing in the examination on which to make an accurate diagnosis. Some sort of cryptic, low-grade infection of an unrecognized organism was suspected. She had been in a state school for the blind and the adequacy of her diet was questioned, but found to have been sufficient. In fact, she had had an excess of orange juice, so that there was no likely possibility of scurvy.

Biopsy.—One loose tooth was extracted and cultures made. These showed almost pure diphtheroid growths and the smears showed a few staphylococci, Vincent's organisms and some amœbæ. The bacteriology gave no special leads. Microscopic examina-

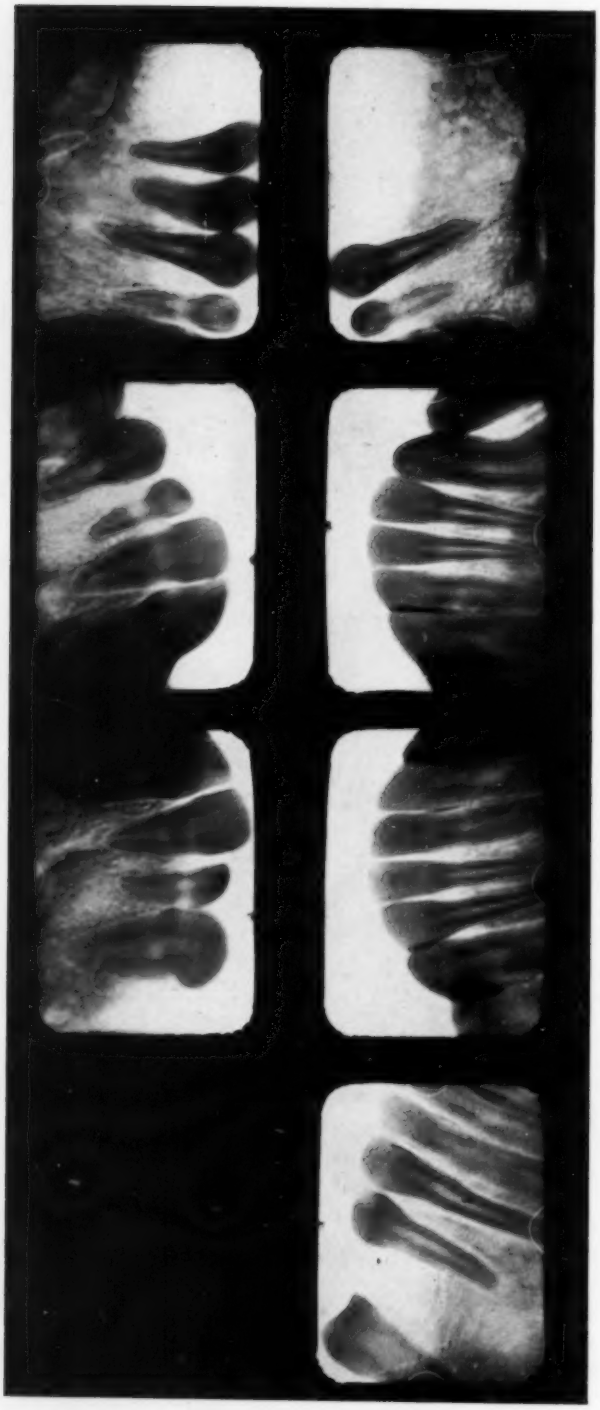

FIG. 2.—Shows absorption of the dental periosteum and of the bone in one of the molar regions.

tion of the gum tissue showed profuse round-cell infiltration with no special arrangement except for an apparent infrequent attempt at acinar formation. (Fig. 3A and B.) Because of the occurrence of the masses in four different areas at the same time, of the infection present and the X-ray evidence of bone involvement, definite views of the occurrence of a tumor were not formulated at first and treatment was guided along lines of local and general supportive measures.

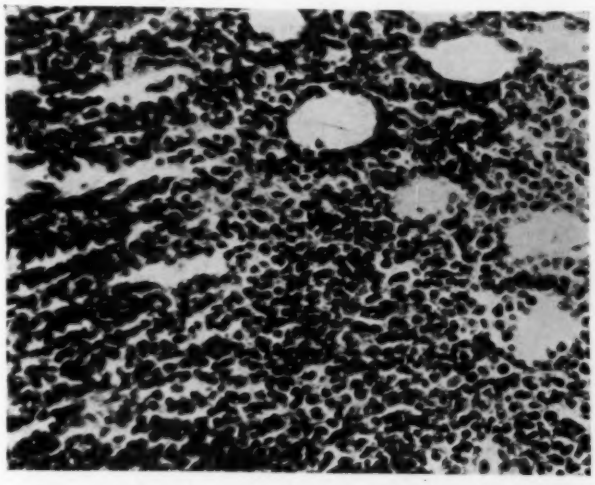

FIG. 3a.—From the gum tumors. Show profuse large round cell infiltration with one area showing something like acini. The cells are of different sizes and a few mitoses are seen.

The Wassermann was negative, urine negative, white blood count 6000 with 36 per cent. lymphocytes, red blood count 4,700,000, hæmoglobin 70.

Treatment at first was essentially to stop infection in the mouth and to keep up the patient's resistance, and many empiric things were tried. Transfusions, full diet (anti-scorbutic) with vitamines, milk injections, ultra-violet radiation, emetin intravenously, constituted the general treatment; and locally, good cleansing care was insisted upon with the use of potassium chlorate, methylene blue and salvarsan. In a week there was much improvement in the incidental infection, the discharge, odor and pain lessening and the teeth tightening up; but the enlargements persisted. In one molar region, the epithelium closed over the mass.

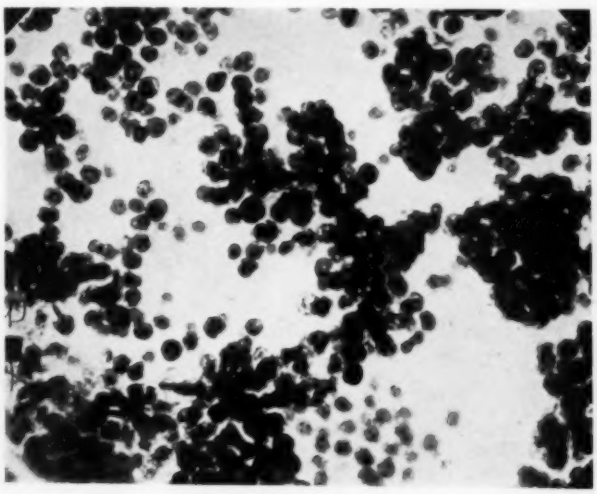

FIG. 3b.—See legend under figure 3a.

X-ray therapy was then used on the gums, and two days later the growths had almost disappeared, and on the sixth day there was practically no evidence of any tumor formation. There was a rather severe general reaction to the X-ray treatment with a good deal of distention coming on just after it which was thought due to the effect of the rapid absorption of the tumors.

The patient had been having pain in both flanks and at this time it settled in the right one and became very severe. An X-ray of the pelvis showed a marked deformity with sacralization of the fifth lumbar vertebra on both sides, most marked on the right, with possible joint formation with the ilium. There was marked distortion of the whole pelvis and both ilia. (Fig. 4.)

At the time of the examination for the pain in the flank, a rectal examination was made and a tumor mass found anteriorly. Its nature and limits were not made out,

however, because of discomfort to the patient and because the pelvic deformity seemed adequate to cause the pain. The patient was put on a fracture board and in twenty-four hours the pain was gone.

At about this time, lumps were noticed in both breasts approximately 2 cm. in diameter. The abdominal distention persisted and warranted a more thorough pelvic examination.

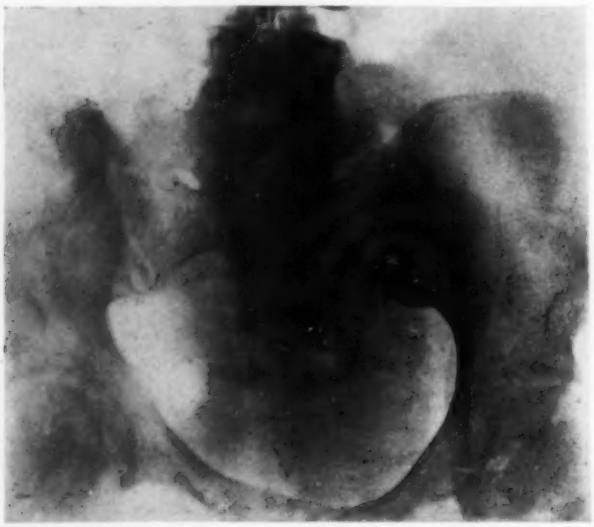

FIG. 4.—Beside the bone deformity, there is shown a partial absence of intestinal gas in the pelvis. This is due to the tumor's filling the pelvis.

Examination by Doctor O'Keefe showed the pelvis and lower abdominal cavity filled with a mass extending to two fingers below the umbilicus on the right and well into the cul-de-sac on the left. The mass could not be outlined or separated from the uterus. The mass was firm but not hard. There was free fluid in the abdominal cavity. The probability of malignancy was considered. Two days later this mass extended above the level of the umbilicus. This rapid growth could not be accounted for by physical examination. Because of this growth and distention without relief from enemata, it was decided to do an exploratory laparotomy at once.

On opening the abdomen, a large amount of free blood-tinged fluid was found in the abdominal cavity. Large ovarian tumors were found on both sides. The tumors were covered by the omentum which was heaped up near the top of the right tumor, which was ruptured at this point. Undoubtedly this rupture took place at the examination two days before and the omentum was attempting to cover up and wall off this raw surface, which accounted for the apparent rapid growth during this period. The tumors were pale in color and very friable.

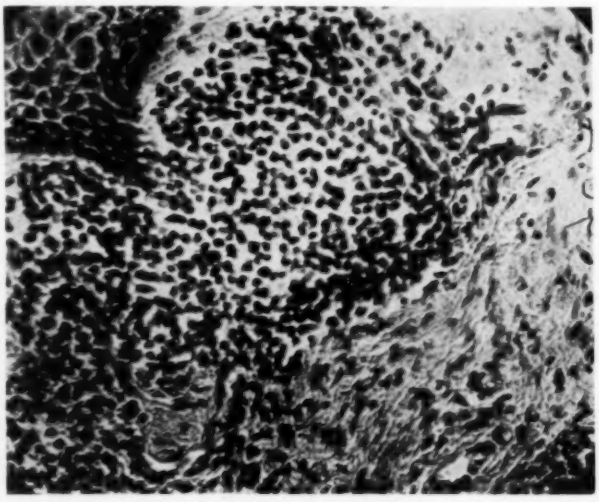

FIG. 5a.—Sections from the pelvic and breast tumors. Show practically the same picture as the gum sections, with no apparent attempt at polarization.

The tumors were removed together with a piece of the omentum and the abdomen closed. A small nodule was removed from the left breast. Frozen sections from both ovarian tumors and the breast nodule showed lymphosarcoma. (Figs. 5A and B.)

Because of the rapid absorption of the gum tumor and the type of cell growth

found, general deep X-ray therapy was recommended, but refused. The patient died on the thirteenth post-operative day.

At the Barnes and the St. Louis Children's Hospitals, in over 69,000 admissions, there have been only four cases of sarcoma of the ovary. The ages were six, seventeen, twenty-two and thirty-one. The percentage of occurrences of sarcoma of the ovary in Barnes Hospital and Children's Hospital was not estimated, although it is reported in the literature as occurring in from two to five per cent. of all ovarian growths.

Sarcoma of the ovary may occur at any age from fetal life on, but occurs much more frequently between the ages of twenty-one and thirty. It occurs much oftener than carcinoma in young girls.

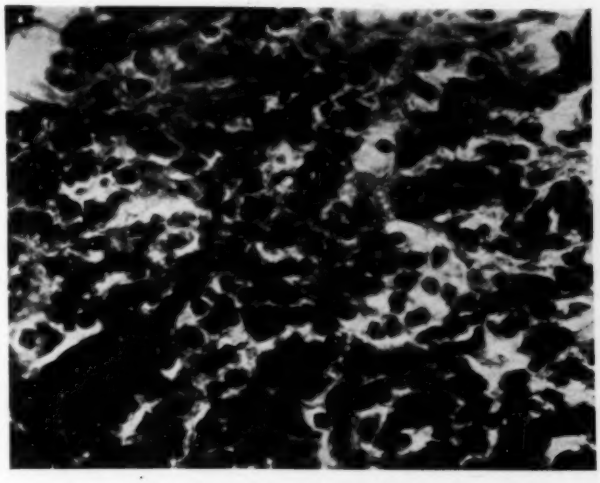

FIG. 5*b*.—See legend under figure 5*a*.

The fact that the patient reported for treatment for the localized involvement of the gums adds especial interest. The primary focus was undoubtedly the ovaries. The simultaneous metastasis to several sites in the mouth at one time, without previous clinical signs from the primary focus, has not been seen by us, with one possible exception, nor can we find any reported cases. It may be possible that this already generalizing growth found lodgement in the gums on account of the trauma of the extraction or of the infection present.

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JAMES BARRETT BROWN, M.D.,
CHARLES D. O'KEEFE, M.D.,
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HORSESHOE KIDNEY

INFECTED HYDRONEPHROSIS

THE following case has seemed worthy of reporting partly because it is a bit unusual but more especially because it serves to illustrate a few rather important points more particularly in connection with diagnosis.

It has been estimated by various observers that horseshoe kidney is noted at autopsies in the proportion of about 1–1000. The number of clinical cases

reported would appear to show an even lower rate of incidence than these figures would indicate. This is rather surprising since the nature of the anomaly is such as to predispose strongly to pathological lesions of various sorts.

In 1924, I made a very careful search and found only 108 cases reported in the entire literature.* To this group we were able to add three of our own cases and we are now adding one more. This group included only clinical cases in which the diagnosis of renal pathology had been made and in which operative relief had been planned and carried out. It did not include autopsy records nor did it include cases in which the anomaly was noted accidentally in the course of operations upon other organs. It omitted also those cases in which the anomaly was noted in the course of making a complete urological examination but in which there was no co-existing pathology in the upper urinary tract. In this group of 108 cases a complete pre-operative diagnosis was made in only 24 or 22 per cent. That is: the pathology was recognized but the anomaly entirely missed in the majority of cases. It is only fair to say that a number of those cases were reported before the advent of many of our modern diagnostic methods. The later groups show a definite improvement in this respect but even the most recent fall short of what should be reasonably expected. This point will be referred to again in the discussion of the present case. Including the three cases reported in my paper of 1924 and the case about to be reported in this communication, we have had four cases in our service at The Brooklyn Hospital. In all cases the pathological lesion was correctly diagnosed but the anomaly was recognized in two only. In the remaining two it was missed pre-operatively and recognized first at operation.

FIG. 1.—Left kidney pelvis much dilated, calyces indefinite, apparently not directed outward, part of pelvis medial to ureter, kidney outline not clearly shown.

* J. of U., December, 1924.

Following is a report of the present case: The patient was a single girl of twenty, first seen on October 5, 1927, who presented the following history: She was in perfectly good health until one year ago, since which time there has been slight frequency of urination accompanied by burning, on one or two occasions she has passed a little blood in the urine. One month ago she had a fever lasting for one week which her family doctor had diagnosed as grippe. One week ago, another attack of fever, this time associated with pain in the left loin, increased frequency and burning on urination. This time her doctor made a diagnosis of pyelitis and referred her to me for further examination. Examination discloses a young Italian girl apparently in good health. The general physical findings are entirely negative, except for some tenderness at the left costo-vertebral angle. Both kidneys are palpable, the left one apparently tender. The urine was cloudy and under the microscope showed very numerous pus cells.

FIG. 2.—Pyelogram of right half of kidney; very irregular shape of pelvis and arrangement of calyces, some of them directed toward the midline.

Cystoscopy on October 6, 1927. There is a mild general diffuse cystitis; the ureter orifices appear normal and are normally situated, number 5 catheters pass readily to each kidney pelvis; clear urine flows in normal rhythm from the right kidney while from the left side there is a steady drip of cloudy urine. Phenolsulphonephthalein injected intramuscularly appears in normal time and concentration from the right side. On the left side there is not a trace of the dye in twenty minutes. Laboratory reports on the separated urines are as follows:

The bladder and left kidney urine showed numerous pus cells and B. Coli on culture. The urine from the right kidney was sterile and free from abnormal elements. A search for tubercle bacilli was negative. The urea was bladder 2.64, right kidney 1.88, left kidney 3.40. I am at a loss to understand the higher urea on the affected side unless it was that this represented the concentrated urine of retention. The blood count showed 12,400 leucocytes, with 77 per cent. polymorphonuclears. The Wassermann was negative and the blood chemistry showed urea 47.5; creatinin 2.13; sugar 129.4; CO_2 combining power 51.9.

Following a plain X-ray of the entire urinary tract a pyelogram and ureterogram were made on the left, using 13 c.c. of a 15 per cent. solution of sodium iodide. The pyelogram shows a much dilated kidney pelvis of somewhat unusual shape with an atypical arrangement of the calyces. (Fig. 1.) The lower pole of the kidney could not be made out. This aroused our suspicions that we were dealing with a horseshoe kidney,

although there was standing against the diagnosis the fact that both kindeys could be palpated and were somewhat movable. For the purpose of clarifying the situation, a pyelogram of the right kidney was made three days later and this confirmd our original suspicions. (Fig. 2.) It will be noted that the kidney pelvis is very irregular in shape, that it is somewhat low and closer to the vertebral column than normal and that some of the calyces point toward the midline.

Diagnosis: Infected hydronephrosis in the left half of a horseshoe kidney.

Operation, October 14, 1927. An oblique incision was made extending from the top of the twelfth rib to the outer border of the rectus, about one inch above the symphysis. An irregular shaped kidney was exposed with a much dilated pelvis presenting on the anterior aspect. Crossing it obliquely was a rather small thickened ureter opening into the pelvis near the hilum with the greater part of the pelvis well below it. The upper pole of the kidney was readily mobilized, the lower pole firmly fixed. Upon tracing this down there appeared in the wound well to the left of the midline the lower pole of the right half of the kidney and connected with the left half by a band partly fibrous about two inches wide and one-half inch thick. A mattress suture was placed in the lower pole of the right kidney near the band, which was then crushed with a heavy clamp and ligated with suture ligatures of chromic gut and the two halves of the kidney separated. This was readily accomplished and there was no bleeding. The remainder of the operation was like an ordinary nephrectomy. It is interesting to note that the vessels entered the hilum at the usual site and that there were no anomalous vessels. The wound was closed in layers with a cigarette drain at the dependent angle. The patient made an uneventful recovery and left the hospital on the fifteenth day post-operative with the wound entirely healed.

FIG. 3.—Specimen removed, showing irregularly shaped kidney, fitting like a cap over greatly dilated pelvis and the ureter inserted near its middle.

Horseshoe kidneys occur with a fair degree of frequency. The very nature of the anomaly predisposes them to various forms of pathology, chiefly because of the irregular arrangement of the pelvis and ureter, which is not conducive to good drainage and hence harbors infection. It is obviously important that the anomaly as well as the pathology should be recognized and yet a complete and accurate diagnosis is unusual in the majority of cases. It is my opinion that, if the diagnostic problem is properly approached, a correct diagnosis should be made in practically 100 per cent. of the cases. The first point is to bear in mind that such a condition may exist, although there are few if any subjective symptoms to suggest it. The most important desideratum is the desirability of subjecting every patient in whom there is

a suspicion of any pathology in the kidney or ureter to a comprehensive examination of the entire urinary tract, including pyelogram and ureterogram of the side under suspicion and where indicated for the purpose of comparison, a pyelogram of the opposite side made at another examination a few days later. I have advocated this policy for several years and have practiced it in my clinic and have never had an occasion to regret it. While it is true that many patients are subjected to much more of an examination than is required to make a diagnosis in their particular case, yet it does them no harm and, on the other hand, I feel that, by following this policy as a routine we often pick up little points that might readily be overlooked with a more casual examination, to say nothing of the fact that we are often able to make a complete diagnosis at one sitting and in that way spare the patient the discomfort and expense of repeated examinations. There is a little wave of feeling among urologists at the present time that pyelograms are being employed too often and too indiscriminately and that they should only be used as a diagnostic proceeding when there are very special indications. I disagree entirely with this attitude. For several years now we have made about one thousand pyelograms annually in our clinic and since using the 15 per cent. solution of sodium iodide, not a single one of this fairly large group has given me one moment's anxiety because of any deleterious effect from the method. It seems to me that a diagnostic procedure which is so innocuous and so often productive of information may well be adopted as a routine. In the case just reported the diagnosis would have been entirely missed without the pyelogram of the affected side and a pyelogram of the opposite side was essential for confirmation.

The diagnostic points of value in the radiographic diagnosis are as follows: The lower pole of the kidney is not definitely outlined. This is important, particularly if the upper pole is clearly seen. Occasionally, as happened in one of my cases, the entire mass, including the isthmus, may be demonstrable. The pelvis is apt to be lower and nearer than normal to the midline, often mesial to the outline of the ureter. A line drawn through the long axis of the pelvic forms an acute angle with the vertebral column opening upward. The opposite prevails in the normally situated kidney. The pelvis is irregularly shaped and the calyces are atypical in their arrangement, some of them often extending toward the midline. When this combination is noticed on the side under suspicion, the diagnosis is strongly suggested. If a similar condition prevails on the opposite side, it is practically confirmed. All of these points are readily noted if one is looking for them; they are easily missed if one is not alive to the possibilities. I am confident that more and more of these cases will appear in the literature in the future and I am equally confident that the ratio of diagnostic accuracy will be much better than the 22 per cent. noted in the review of 1924 or the 50 per cent. noted on our own four cases.

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ENTEROSTOMY IN TYPHOID PERFORATION

The value of prophylactic, or complementary enterostomy in abdominal surgery has been conclusively shown. It has been employed in resections of the large bowel, and it is routinely done in this clinic. In cases of intestinal obstruction, with or without mechanical cause, many surgeons have employed it to avoid the dangers of paralytic ileus. More recently in suppurative appendicitis where ileus is present or feared, enterostomy has reduced the mortality perceptibly.

I have had within the past two months two cases of typhoid perforation of twelve hours' duration; the first was treated by closure of the perforation, enterostomy and drainage. When the second one came in, it occurred to me to try a procedure I do not remember seeing described before. Instead of closing the perforation with a purse-string suture, and doing an enterostomy proximal to it, I inserted a small rubber catheter into the ileum through the perforation and sutured it in place after the Witzel method. The catheter was brought through a stab wound in the flank; the incision was closed. Both patients drained freely through the catheter, and there was no distention. Their convalescence was uninterrupted, the catheters came out in ten to fifteen days and the fistula closed spontaneously and promptly. Both were discharged well.

If there should be more than one perforation, I should close the distal ones as usual and insert the catheter into the proximal one. The fact that in these as well as in similar cases death is so often due to the results of paralytic ileus, enterostomy will certainly prove a life-saving measure. The procedure described is so simple, works so well and proved so satisfactory it seemed worth reporting.

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BOOK REVIEWS

POLIOMYELITIS, WITH ESPECIAL REFERENCE TO TREATMENT. BY W. RUSSELL MACAUSLAND, M.D. Octavo, cloth, pp. 402, profusely illustrated. Lea and Febiger, Philadelphia, Pa., 1927.

This book ably and comprehensively presents the important subject of poliomyelitis, bringing the advances in experimental study and treatment up to date. As would be expected, when an orthopædic surgeon writes upon this subject, special attention is given to treatment, but history, etiology, pathology, diagnosis, prognosis and symptoms, in Part I (about one-third of the book), are fully presented. This part reflects intensive study of what others have done. In reviewing and ably marshalling the observations of other workers, the author has given due credit and each chapter is followed by its own bibliography. In Part I, the writer weighs the evidence on the vexed questions of bacterial etiology, of immunization and of vaccine therapy. This part also includes an interesting review of the history and of the spread of the disease in epidemics in both hemispheres; it clearly presents the pathology, symptomatology and diagnosis, and rightly advances a better prognosis as to ultimate usefulness than is often expected or taught. Part I should be of especial interest to the general practitioner, to the pediatrist and to the neurologist.

Part II (two-thirds of the book) is devoted to treatment. In its first chapter, there is a good outline of the symptomatic treatment of the febrile stage, of the symptomatic and muscle conservation treatment by local protection of the early paralytic stage and of the protective and muscle development care of what might be called the mid-paralytic stage; and finally of the great advance in reconstruction by operation, when the residual paralyses are established. For the febrile and early paralytic stages, the use and place of lumbar puncture, of vaccines and of drugs is discussed. Here also is found a clear presentation of the mechanical causes of deformity and of its prevention. Could the general practitioner thoroughly know the principles presented in this chapter and authoritatively transfer that knowledge to patients and to parents, it is believed that much of the disability and deformity which follow poliomyelitis would be lessened.

The remaining chapters are devoted to specific orthopædic problems in treatment. The disabilities and deformities of the lower extremity, of the upper extremity and of the spine and trunk are presented seriatim and fully. Protection by braces, by plaster-of-Paris dressings is detailed for specific conditions; graduated and progressive muscle training principles and lists are applied each to its disability. Finally the methods of reconstruction, by operation, when preliminary care has left a disability or disabilities upon which no further advance may be expected, or when neglect has left these disabilities plus deformity, are described for many individual conditions.

This part reflects the author's personal experience. The procedures are fully illustrated—even, as in Whitman's astragalectomy, more fully than did the originator of the operation. The indications for tendon transplantation and for "bone carpentry" work are differentiated. One misses reference to the valuable principle of partial or stop-joint fixation of joints by the use of transplanted autogenous "living ligaments", made from twisted fascia lata, as described and used by Gallie. This procedure has found a definite place in operative paralytic reconstruction; its omission in this work is regrettable.

Viewed as a whole, this book shows thoughtful library research and careful adaptation of the matter there found and much personal experience in the practical side, which is instructively presented. There is a full index at the end of the book.

WALTER TRUSLOW.

PRACTICE OF UROLOGY AND SYPHILOLOGY. A Surgical Treatise on Genito-urinary Diseases and Syphilis. By CHARLES H. CHETWOOD, M.D. Profusely illustrated. Octavo, cloth, pp. 879, 4th edition. New York, William Wood and Company, 1927.

The first edition of Doctor Chetwood's book appeared in 1913. It at once acquired an authoritative position in the specialty to which it was devoted, which has been maintained in the successive editions which have been since called for. It must be a cause of much satisfaction to the author, as the years of his own life have been added to until they now have brought him among the seniors of his profession, to see the permanence of the work he has done and the importance of the structure that he has builded. At the beginning of this period, Urology had already been accepted as an important surgical specialty, an importance which has steadily increased to the present time due to the advance in the knowledge of pathology, the improvements in diagnostic methods and the greater possibilities of adequate treatment which time has brought. To the urological part of his scheme, Doctor Chetwood has devoted 725 pages of his book. His statements of fact are brief and condensed but clear. So extensive has become the field, however, that one cannot help but feel that even so many pages of a book are not adequate to do full justice to the subjects treated. As one reads, one's appetite is whetted for more that the author could have given. This is merely a bald statement of the present field of surgical science and practice any one major department of which now demands for its adequate treatment more space than did the whole field of surgery in the days of Erichsen, Syme or Gibson. This is especially true of the part of the book devoted to syphilology, occupying 124 pages. One finds it difficult to justify the association of syphilis with urology; it is certainly not a necessary one; true in many instances, it finds its origin in a lesion of a urological organ; a fact which, however, is an accident, rather than a constant. As a disease, it has a far more important relation to almost any other tissue or set of organs than to those of the uropoietic system.

LEWIS S. PILCHER.

THE OPERATIONS OF SURGERY. By R. P. ROWLANDS, M.S., F.R.C.S., and PHILIP TURNER, M.S., F.R.C.S. Seventh edition, large 8vo, cloth, 2 vols., pp. 1046 and 896; profusely illustrated. The Macmillan Company, New York and London, 1927.

Twenty years ago, in 1907, it was the privilege of the writer to review in the ANNALS OF SURGERY, vol. xlviii, p. 951, the fifth edition of *Jacobson's Operations of Surgery*. Mr. Jacobson, in that edition, acknowledged the joint authorship of Mr. Rowlands. The book, in its seventh edition, again appears on our table for review, but has lost the name of Jacobson. Rowlands is now the senior author, while as a junior colleague, his fellow surgeon at Guy's Hospital, Mr. Turner, has been added. As is most proper, the present authors pay a deserved compliment to their predecessor in the compilation of the book. In their words, the book was first written by "that incomparable and gifted teacher, the late Mr. W. H. A. Jacobson, who, endowed as he was with great natural and literary ability, extensive surgical knowledge, ripe judgment and endless energy, was able to make the book an immediate and lasting success. Jacobson devoted over twenty years to succeeding editions, allowing himself hardly any spare time and often working in the small hours when he ought to have been asleep. Let us hope that the book may remain a lasting memorial to his genius and industry."

Mr. Jacobson died in 1924. Should his personality be still conscious of earthly conditions, it could not fail to delight him that the work to which he gave himself with such devotion during his life in this world was still being carried on by able and enthusiastic successors whom he had himself trained and imbued with his own enthusiasm.

This is a Guy's Hospital book. It is dedicated to that hospital, and its authors are members of its surgical staff and lecturers in Surgery in its Medical School. It is not desirable here to make a detailed review of its scope or of its chapters. It is a practical book, an up-to-date book. It has evidently been especially prepared with a view to the needs of younger and inexperienced surgeons. In this latest edition it is apparent that much of it has been rewritten to make it properly embody the surgery of to-day. All surgeons will find it an excellent and authoritative guide.

JAMES T. PILCHER.

RADIUM IN GYNÆCOLOGY. By JOHN G. CLARK, M.D., CHARLES C. NORRIS, M.D., and GIOACCHINO FAILLA, E.E. Large octavo, cloth, pp. 303. J. B. Lippincott Company, Philadelphia and London.

Medical literature, during the past few years, is so replete with reference to the use of radium in various conditions, that it is with interest and profit that one reads the present and probably pioneer exposition of its employment in gynæcology by authors especially qualified to correlate the scientific and practical aspects of the questions involved. The first half of the work is taken up by an exhaustive and scholarly consideration of the physics of radium. This section, while of unquestionable intrinsic interest, will certainly best be

appreciated and understood by special workers, especially by those in the field of preparation of the substance for practical use. This section is preceded by an introductory chapter reciting the history of the discovery of radium and the relation of Becquerel, Rutherford, Schmidt and Curie to the development of its recognition. The life of Mme. Curie is of dramatic interest.

The authors are most emphatic in their attempt to make one realize that its indiscriminate use should be guarded against and that insufficient knowledge and experience are likely to do much harm. Their primary concept is accuracy of diagnosis and they base their efforts at treatment on a sound knowledge of pelvic pathology and objective findings, acknowledging the paucity of actual demonstration as to just how radium affects carcinoma, but recite the conditions and pathology which they have noted to be most beneficially affected in the observation of a convincing number of cases.

This is included in the chapters dealing respectively with tumors of the external genitalia, vagina, cervix uteri, body of the uterus, myoma uteri and myopathic hemorrhage, cervicitis, sterility and dysmenorrhœa. The type of cases suitable for treatment in these regions, their recognition and the technic of radium application are definitely stated.

The volume is certainly a real addition to our armamentarium in the treatment of pelvic conditions and should be carefully read by those attempting to employ this agent in the field of gynæcology.

JAMES T. PILCHER.

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